• Volume 6B, Number 3—4, October 1957

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BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

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Bull. Res. Counc. of Israel. B. Biol. & Geol.

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CONTENTS

CHROMATOPHORE STUDIES
III. STRUCTURAL CHANGES IN THE PERITONEAL MELANOPHORES IN *PELOBATES SYRIACUS*

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ABSTRACT

(1) Development of hydropsy in the larvae of *Pelobates syriacus* and *Bufo viridis* can be induced by exposing eggs in the gastrula stage to a temperature of 4—5°C for 6—11 days.

(2) Anatomical alterations in these hydropic larvae include a general retardation of development, reduction in the length of the tail, microcephaly, an extreme reduction in the size of the eyes, changes in the form of the heart and the intestinal tract which is only one third as long as normal, alterations in the form of the pronephric tubuli together with an extreme swelling of the abdominal cavity.

(3) The high pressure on the inside of the abdominal wall gives raise to changes in the form of melanophores covering the inner and outer side of the peritoneum.

The pigment cells of the inner layer stretch out in all directions. They send out fewer and thinner but longer cell processes than normal, which attach themselves to similar processes of other cells. In this way a kind of abortive network is formed which resembles that found in the adepidermal melanophores of the Discoglossids.

The pigment cells of the outer layer, as far as they remain attached to the peritoneum, show similar changes to those of the inner layer. Many of them, however, become detached and grow along the membranes and threads of connective tissue- and muscle fibres. If they remain on the surface of larger membranes their form is similar to that on the distended peritoneum. If they grow along thin fibres, however, their form becomes elongated, thread-like, and in extreme cases they may lose all lateral cell processes.

(4) Cell division in these melanophores with altered shape remains normal.

(5) The results obtained show the dependence of the form of the peritoneal melanophores on the dynamic conditions of pressure and tension in the substrate on which they grow.

INTRODUCTION

In the course of experiments with embryos of *Pelobates syriacus*, a number of larvae with hydropic swelling of the abdomen occurred, which suggested that such abnormalities could be induced through cold. In a new series of experiments, in which eggs of *Pelobates* and *Bufo* in the gastrula stage were exposed to low temperatures for a week and longer, a relatively large number of hydropic tadpoles were obtained ranging from almost normal larvae with only a slight swelling of the abdomen to larvae which seemed to be only an appendix to an enormous abdominal vesicle.

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Especially in these extreme larvae, considerable alterations in the form of the melano phores of the abdominal wall occurred. These constitute the subject of the presen investigation.

MATERIAL AND METHODS

In a first series, eggs of *Pelobates syriacus* Böttch. in the early to the late stage o gastrula were collected in the open, placed in an ice box at +4 — +5°C for 11 day and then allowed to develop at room temperature (13 — 15°C). Mortality in earl stages was rather high, about 60% not attaining the tail bud stage. From the rest about 25% developed apparently normally and were discarded at the end of th experiment. The rest (15%), already 5 days later began to show a swelling of th abdomen, together with a decided retardation of the growth of the head regior Later on, the hydropsy of the abdomen increased, and the young larvae lay on th bottom of the glass dish or swam upside down in the surface of the water. Thei swimming was very awkward and movements of the tadpoles did not occur unt disturbed. The larvae lived from 17 to 28 days and eventually died. Most of ther were fixed about 17—20 days after they were taken from the ice box, stained i toto with Hemalum, cleared in clove oil, where total preparation of the distende abdominal wall was carried out. Though it is easy to remove the skin from th abdominal wall, also in extreme hydropic larvae, it is almost impossible to separat the peritoneum from the muscular layer which is firmly attached to it; in norma larvae, this too is easily done. These pieces of the abdominal wall were then tran ferred into Canada balsam. As these stretch preparations are not entirely flat, micr photography of the structural details of the melanophores is almost impossibl Therefore drawings where made with the aid of a drawing apparatus.

In a second series, gastrulae of *Bufo viridis* Laur. were exposed to +4 — +5° for 6 days. Mortality in early stages amounted to about 30% and later also a numbe of hydropic larvae developed, which however did not show such an extreme dilatatio of the abdomen. As only the most extreme cases of hydropsy show considerabl changes in the form of the melanophores, only the first series of experiments wi be dealt with here in detail.

ANATOMY OF THE HYDROPIC LARVAE

I am referring here only briefly to the major changes in gross anatomy which wer observed in the hydropic tadpoles. Figure 1a, b gives the dorsal and ventral vie of an extreme case of hydropsy 20 days old. The sketch is drawn from a specime in alcohol which was afterwards cleared in clove oil to show more details of th organs. Figure 1c represents a normal larva from the same lot of the same hea and-trunk length. The hydropic larva is much retarded in development as may b seen in the presence of the adhesive disc (ad) and the primitive development of th mouth (m). The tail is very short, having only about half the length as norma Also the tail fins are much more narrow than normal. The head is typical micr

cephalic, though the proportions of the different parts of the brain (b) are apparently normal. The eyes (ey) may be extremely small in comparison with those in normal tadpoles (Figure 1c, ey) and do not touch the skin. These changes occur in all extreme cases of hydropsy, but it cannot be ascertained whether they are also the direct results of the development of the hydropsy as those reported later, or whether they are only due to the same primary causes which later on lead to the formation of a hydropsy of the abdomen.

True hydropic changes are found in the enormous swelling of the abdominal cavity which may reach about the same diameter as the length of the head and trunk. This means that the shape of the body is almost globular and only somewhat flattened dorsally. There are usually also three smaller hydropic vesicles in the head region, two lateral the eyes and one medial between the nostrils. Owing to the distension of the skin, the opercular fold (op), which normally closes into a spiraculum (sp) on the left side of the body, remains wide open. The heart (h) is very small, elongated and shows a hook shaped curvature. Its beats can clearly be observed in life through the distended skin. The digestive system is much reduced and attached to the dorsal side of the abdomen. Stomach and intestine (s, i) are very slender and run almost straight from the mouth to the anus. The intestinal spiral is completely missing. The liver (l) is relatively large and its lobes lie openly on the right side of the intestine. The anus is very much enlarged and its transition to the slender intestine is very abrupt. The pronephros (pn) is pressed closely against the skin and therefore clearly visible from the dorsal side. The three tubules on each side are elongated and far less convoluted than normal. They run into the Wolffian duct (wd) which lies lateral of the myotomes.

THE PERITONEAL MELANOPHORES

The peritoneum, which lines the abdominal cavity, consists of a very thin layer of mesothelial cells which is attached to the muscles of the abdomen by a very loose connective tissue. Both sides of the peritoneum are covered with dense sheets of pigment cells. In the stage previously described, only melanophores are present, but in older tadpoles also guanophores occur.

The inner layer (Figure 2) consists of a large number of flat and circular melanophores with numerous stout and relatively short rays, which if expanded, touch each other so that it is difficult to establish the individuality of the single pigment cells. If slightly contracted the outer border of their territory is often indicated by a narrow line free of pigment which separates the adjacent melanophores. In the stage of medium contraction broader spaces, free of pigment, surround the single cells. Variation in the stage of expansion is usually not very great, and in life most of the melanophores are fully expanded. Their nuclei are mostly clearly visible as a spot free of pigment in the centre of the cell.

The outer layer of melanophores (Figure 3) is very similar to the inner one but some differences are noticeable. First, the pigment cells lie more scattered and do

not always touch each other. Their shape is somewhat more irregular, cell processes are fewer and stouter, and the cell body without rays much larger. Nuclei are not visible in all cells, but they may be found as well in expanded as in contracted ones. In comparison to the inner layer the melanophores seem to contain slightly more pigment granules. Variation in the expansion of the cells is very great as all stages between complete expansion to complete contraction can be seen in one preparation.

The following drawings have been made of a number of different cases of hydropic larvae. Changes in the form of the pigment cells range from an almost normal shape to forms which would no longer be recognized as peritoneal melanophores. Significant changes in the form of the melanophores occur first in larvae with a middle degree of hydropsy (length of the body without tail: largest breadth is about 7:5.5). In lighter cases the melanophores seem to be normal.

Figure 4 gives a ventral portion of the peritoneum of a case of large but not maximal hydropsy, 18 days old (the time is always given after the withdrawal from the ice box). It shows the inner layer of melanophores and below the fibres of the musculus rectus, which run parallel, but which are drawn out transversally through the pressure of the abdominal fluid. The melanophores are more flattened than normal, their cell body is much larger in proportion to the rays which are fewer and shorter. The connection of the melanophores by thin and slender processes should be noted. There is also no relation between the course of the muscle fibres and the position of the pigment cells, which may lie across several fibres.

Figure 5 gives a picture from another animal of the same series. It shows, at low magnification, the dorsal portion of the musculus obliquo-transversus with the peritoneal melanophores attached to it. Besides pigment cells which seem almost normal only for their few long and slender processes which spread regularly across the muscle fibres, a number of cells may be noted, which distinguish themselves by their very elongate form; their rays are sometimes attached to the muscle fibres.

In two other cases of extremely developed hydropsies 18 and 19 days old, we see a further development of the peritoneal melanophores of the inner layer. In Figure 6, the single cells are farther away from each other, the cell processes are much larger and longer, and most of the cells are connected with each other through these pigment threads.

Figure 7 gives an even more extreme case, in which the cells lose their circular shape, become more elongate and send out fewer but much longer rays, which attach themselves to similar processes from neighbouring cells. In this way a form of a primitive network of pigment cells is formed, with irregular polygonal meshes. But this abortive network is always found only between a few cells (8—20) and never includes all peritoneal melanophores. It is only found in the more dorso-lateral portions of the peritoneum. This picture shows also a pigment cell in the metaphase stage of cell division. Dividing cells are found occasionally, probably not more rarely than normal, and this already shows that the alteration of their cell form is no obstacle to cell division. It also shows, that we must look upon the physiological conditions under which these cells develop, as not unfavourable for further development.

A number of the melanophores of the outer peritoneal layer remain attached to the peritoneal membrane, flatten out and form groups of cells connected with each other through their long and slender processes as shown in Figure 8.

But a number of the melanophores of the outer peritoneal layer usually detach themselves from the peritoneal membrane and creep along the fibres of the muscle bundles and the connective tissue. Here we may observe the most striking changes in the form of these cells. In Figure 9 we see a number of thin muscle fibres from the musculus obliquo-transversus from an extreme hydropic case 19 days old. As long as the muscle fibres are spread out and connected by a thin membrane of connective tissue, the melanophores are flat, rounded and creep along the surface of this membrane. If the threads of muscle cells become narrower, the pigment cells elongate and retract most or all of their processes. Two details of another very similar case of extreme hydropsy are given at larger magnification. In Figure 10, a thin strand of muscle fibres with 4 melanophores attached to it is shown. Where the bundle broadens (left), the melanophores are more or less circular. Where it becomes narrow, the pigment cells become threadlike and lose their cell processes.

In Figure 11, two strands of muscle fibres are connected by a membrane of connective tissue. It shows that even a little larger surface enables the melanophores to retain their flat and more or less typical form. Only where they are attached directly to an intermuscular space (a) or where they run along a fibre of connective tissue which runs above the membrane (b) they become filiform. The large melanophores on the left are probably polynucleate, as 2 resp. 3 nuclei were counted and no borders of the individual cells could be detected.

Figure 12 gives a strand of connective tissue which runs down from a connective tissue membrane. The form of melanophores is similar to that in the two former cases. On the left upper side it shows 2 or 3 melanophores which are still attached to the peritoneum but which run along a short fibre of connective tissue which attaches the membrane to the peritoneum.

An extreme case is finally drawn in Figure 13, where an almost thread-like peritoneal melanophore runs along the edge of a membrane of connective tissue. In comparing this cell with the picture of normal melanophores as given in Figure 3, the change in the form of the melanophores is realy astonishing. I would have hesitated to attribute this cell to the peritoneal melanophores, but, as I have shown in the previous pictures, as all transitions of form exist between the normal shape and this extreme, there can be little doubt that we really have here a very altered melanophore of the abdominal wall before us.

DISCUSSION

Little is known about the primary causes of the development of hydropsy, but it may be fairly assumed, that it is in general due to a change in the water metabolism

in the embryo and the young larva, through environmental changes. This is not only suggested by our experiments with low temperatures, but also by experiments of Tornier (1908) and Sladden (1930, 1932). Tornier raised eggs of the axolotl in a well planted aquarium, which stood in the dark and where the plants used up most of the ogygen in the water for respiration. A number of hydropic larvae resulted from this cultures. He also treated eggs of the axolotl, frogs and toads with solutions of 5—25% cane sugar for 48 hours, and here also hydropic larvae were obtained. He compares his results with the occurrence of fishes with a swollen abdomen which are frequently found in some races of the Chinese goldfish (i.e. race "ranchu"). Sladden repeated these experiments and treated eggs of *Rana temporaria* 24 hours old, and blastulas for 3—8 hours with solutions of 10—25% cane sugar. She also tried to reduce the ogygen content of the water through low pressure (300 mm below normal for 4 hours). In all experiments she obtained hydropic tadpoles in early stages besides other abnormalities which became manifest only in older larvae. It also seems to be the common experience of all workers experimenting with amphibian—especially urodelan—embryos, that hydropic larvae often occur in some batches of eggs more often than in others, and this is usually attributed to a general weakening of the eggs through the operation or to an inadequate treatment of the embryo. These experiments already show, that a number of heterogeneous stimuli as cold, low oxygen content of the water, changes in the osmotic condition through sugar, or development of the naked embryo in 0.2% Ringer's or Holtfreter's solution, or shock of the embryo through the operation, affect the water metabolism in the embryo. They show furthermore, that already in the egg 24 hours after fertilization, the presumptive region which will later be the morphological base for the control of the water metabolism, is highly susceptible to these stimuli.

A few words should be said regarding Tornier's view on the origin of the abnormal races of the goldfish in China and its comparison with the hydropic tadpoles obtained in his and our experiments. In old days in China goldfish were raised under very unfavourable conditions. They were kept during winter time in dishes in dark places (probably also with water plants) without frequent changes of the water. In summer time they were placed in the open in overcrowded pools, and so naturally a number of abnormalities occurred which were selected out by the Chinese who are very fond of these freaks. After a large number of generations of maltreatment these races were firmly established (probably through the occurrence of mutations).

But if we compare these races of the goldfish with "swollen" abdomens, as e.g. described in the beautiful drawings of Martinet (1780), with our hydropic tadpoles, we immediately realise that the cases are completely different. Races of goldfish as the "ranchu" exhibit an extreme shortening of the head and trunk region ("bulldog head") and an extreme skyphosis of the vertebrate column. As these races are completely vital and the volumen of the viscera must remain the same as in the normal goldfish, the abdomen must distend ventrally and laterally to take up the internal organs. In this way the whole shape of the body becomes ovoid, and the abdomen is

completely filled out. In the case of true hydropsy the reverse takes place. The wall of the abdomen is distended and the internal organs occupy only a very small portion of the cavity. They are so much reduced that feeding and digestion is impossible, and the animals die of starvation. The primary cause of the development of the abdominal swelling in the goldfish is therefore the reduction of the length of the skeleton, but in the tadpoles it is a disturbance of the water metabolism.

When only a slight hydropsy has once occurred in the larva, the fluid in the abdomen presses against the abdominal wall and the pronephros hindering the excretion of the superfluous body fluid. This increases the pressure on the pronephros and excretion is even more checked. With the increase of the body fluid, the abdominal wall is inflated like a balloon and the pronephros pressed tightly against the muscular tissue in the abdominal wall so as to stop excretion completely. We may compare this situation with an inflated rubber balloon, the one side of which is thickened (dorsal side) and the other side thinned (ventral side) (Figure 14a). The pressure in the interior, which is indicated by arrows, is the same in all directions. The intensity of tension within the wall depends on its thickness and is therefore much larger on the ventral side than dorsally. This means, by an increase of tension, the ventral parts of the ball become even more compressed and thinner. There results also another tension which acts within the wall in, let us say, a tangential direction. This tension is smallest on the dorsal side where the wall has its greatest thickness and largest on its ventral side. It gradually increases in the lateral parts from dorsal to ventral. Figure 14c gives the forces of tension of one point of the ventral side as seen from the surface of the wall. Tension is very great and is similar in all directions. Figure 14b gives the same for one point on the dorso-lateral side. Here tension is in general smaller and different in different directions. It is smallest dorsally and largest ventrally.

If we apply this scheme to the abdomen of a hydropic tadpole, we may conclude that the whole abdominal wall is compressed and its elements (skin, muscular tissue and peritoneum) which are normally separated by a loose mesenchyme, are closely pressed together and distended. Peritoneum and skin yield to this tension by an active increase of their surface, but the muscles increase their surface by other ways. The musculus rectus which runs in a cephalo-caudal direction on the ventral side, is flattened and drawn out transversally. Its single muscle bundles are no longer lying close together as normally, but are drawn out and form a kind of network of very long meshes (Figure 4) which is filled with strands of connective tissue. On the lateral side lies the system of the musculus obliquo-transversus which runs obliquely from the myotomes to the ventral side. As tension is larger on the ventrolateral side than on the dorso-lateral one, the fibres of these muscles are drawn out in a fan-like manner, i.e. ventrally more than dorsally (Figure 5).

DYNAMIC CONDITIONS UNDER WHICH THE MELANOPHORES DEVELOP

In all cases there is a pressure perpendicular to the body of the pigment cells. On the ventral side, radial tension is alike in all directions and on the lateral side, tension is largest in one direction (dorso-ventrally). If we now compare the shape of the melanophores as described previously, we observe that first all melanophores are flattened. The pigment cells of the ventral side are drawn out radially and remain more or less circular, while those of the lateral side are elongated and in extreme cases, threadlike (i.e. drawn out in one direction). But this shape will probably not be entirely due only to this tension. We already know from the experiments of Harrison (1910) that embryonic nerve cells grow with preference along threads in the surrounding medium, either along fibres of fibrin or threads of a spider web.

This stereotropic outgrowth is also observed in our experiments where the melanophores of the outer peritoneal layer grow with preference along the threads of muscle or connective tissue fibres. It is also possible, that this attachment influences to a certain degree the elongate shape of pigment cells, but this certainly is not the only cause. Weiss (1928, 1929) Doljanski and Roulet (1933) and Düggeli (1937) showed that in vitro fibroblasts grow more actively in the directions of highest plasmatic tension, and especially the pictures of Weiss clearly show, that this growth is not only due to more intensive cell multiplication but also to changes in the form of the fibroblasts. In places of low tension (towards the edges of the triangular plasma clot), the cells show their normal shape with 4—6 processes which grow out in all directions. In places of high tension, the cells are very elongated in the direction of highest tension, and their processes — if present at all — also point in this direction. In these experiments, only very fine plasmatic fibrillae are present which however can already be detected in vivo by the use of polarized light (Düggeli 1937). This indicates that the presence of muscle or connective tissue fibres are not necessary for the development of the elongate form of melanophores though they may help.

I already mentioned that the peritoneal mesothelium is much distended and yields to the internal pressure by an active enlargement of its surface. But the melanophores multiply not to the same degree and therefore, we find them more scattered. Where processes of different cells are attached to each other these processes are drawn out and in extremes cases a kind of an abortive net of melanophores may be formed (Figure 7). This network of pigment cells greatly resembles the nets of adepidermal melanophores during development and regeneration as described by us (Bytinski-Salz and Elias 1938, Bytinski-Salz 1939) in *Discoglossus* and *Bombina*. Unpublished experiments on *Discoglossus* lead to the conclusion that everywhere where fully developed cutan and subcutan melanophores are present and where very active growth occurs (as e.g. in the outgrowing limb bud), the melanophores are drawn out passively, and abortive nets of pigment cells occur. As the adepidermal melanophores of the Discoglossids are the ones which show the least activity and growth of all the melanophores of the skin, it is not impossible that they once acquired

(through mutation?) a lower rate of growth which, together with their other physiological properties led to the formation of these structures. Perhaps this may be one clue to the origin of those peculiar adepidermal melanophore nets.

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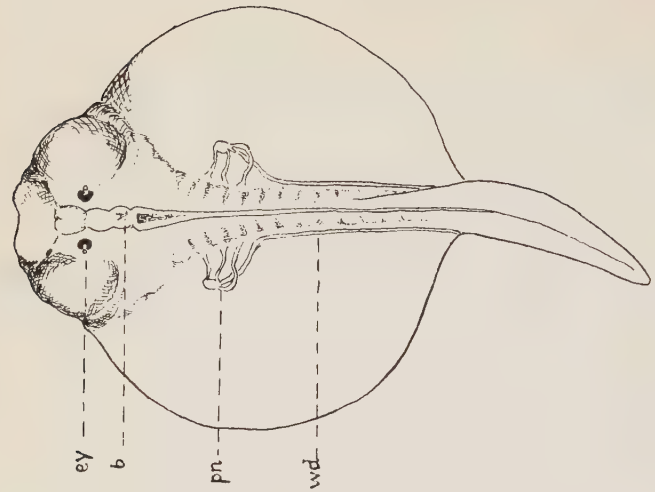

Figure 1a
Hydropic tadpole of *Pelobates syriacus*. Dorsal side

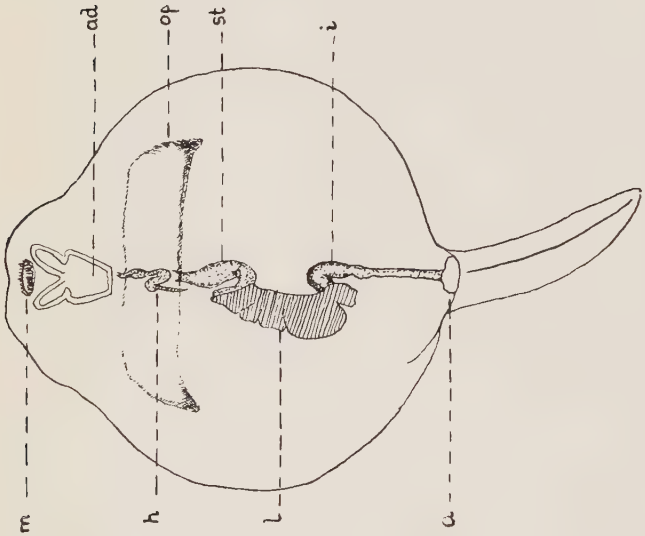

Figure 1b
Hydropic tadpole of *Pelobates syriacus*. Ventral side

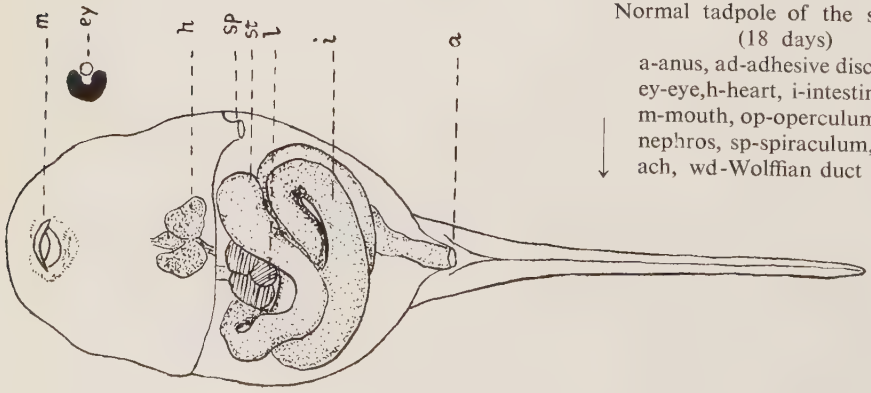

Figure 1c
Normal tadpole of the same age (18 days)
a-anus, ad-adhesive disc, b-brain, ey-eye, h-heart, i-intestine, l-liver, m-mouth, op-operculum, pr-pronephros, sp-spiraculum, st-stomach, wd-Wolffian duct all 8.5 ×

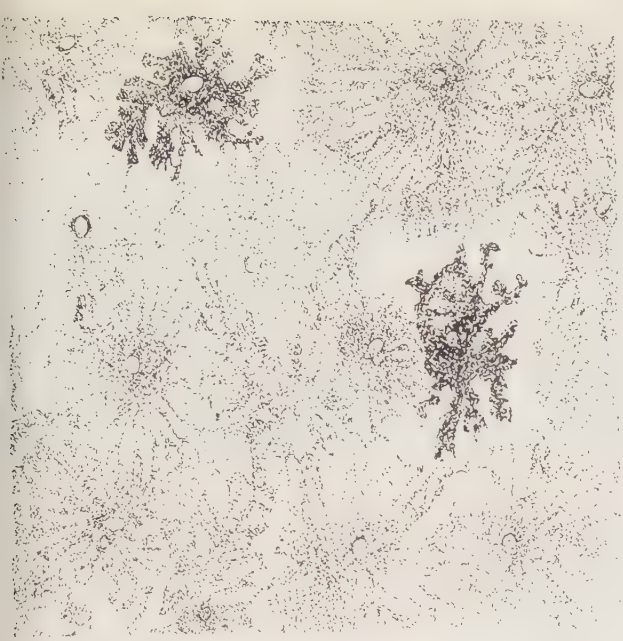

Figure 2
Normal melanophores of the inner side of the peritoneum (20 days) 360 ×

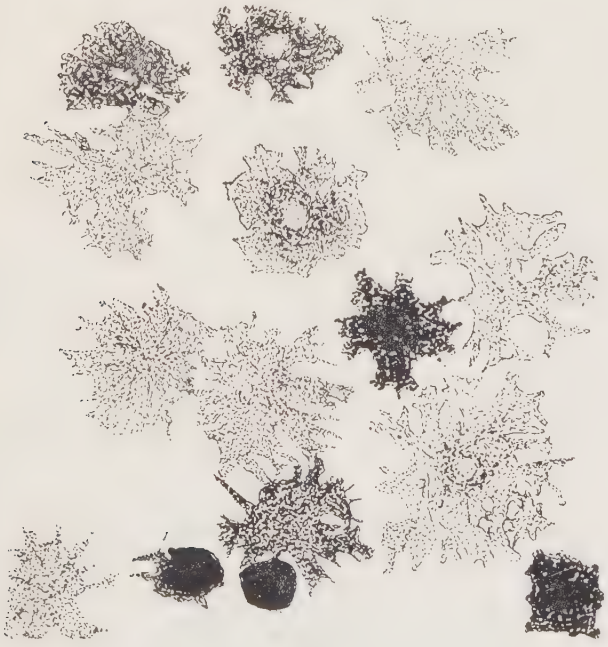

Figure 3
Normal melanophores of the outer side of the peritoneum (20 days) 360 ×

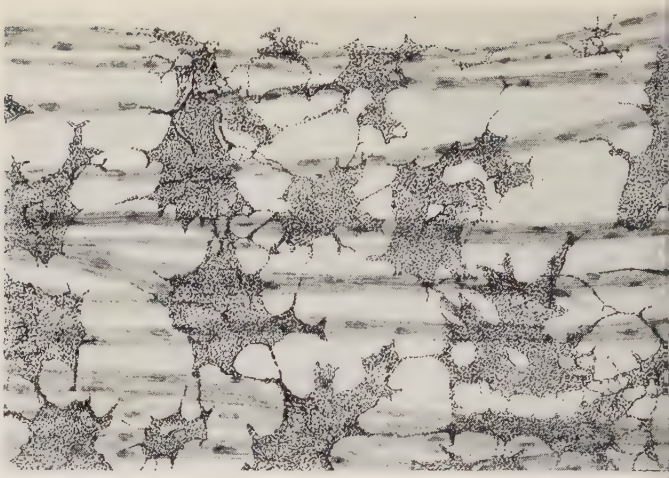

Figure 4
Hydropic larva (Pex 164) 18 days old. Inner layer of melanophores 360 ×

Figure 5
Hydropic larva (Pe 162) 18 days old. Inne layer of melanophore 65 ×

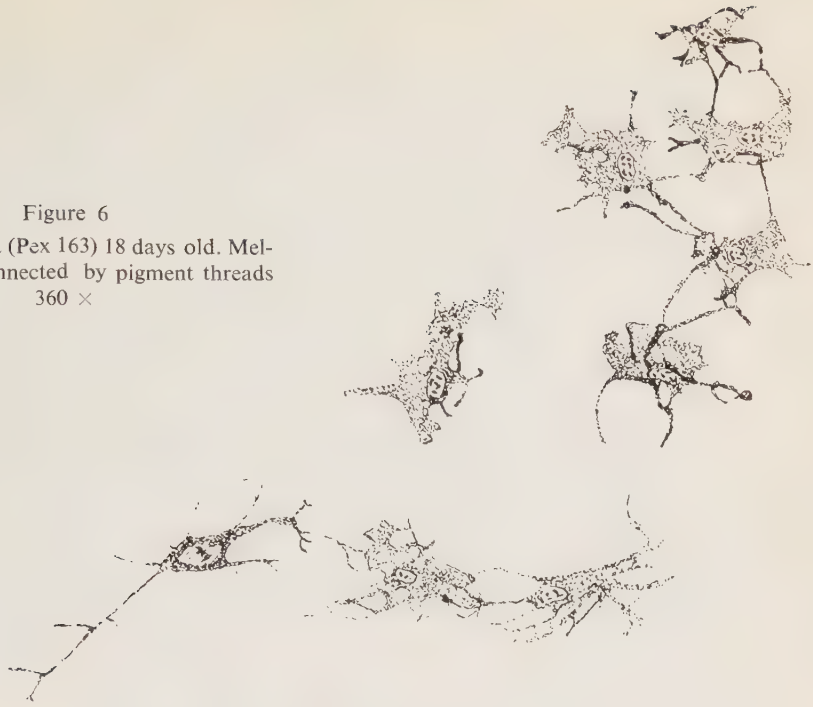

Figure 6
Hydropic larva (Pex 163) 18 days old. Melanophores connected by pigment threads 360 ×

Figure 7
Hydropic larva (Pex 125) 20 days old. Melanophore net at left cell in division 380×

Figure 8
Hydropic larva (Pex 123) 20 days old. Outer layer of melanophores with dividing cell 380×

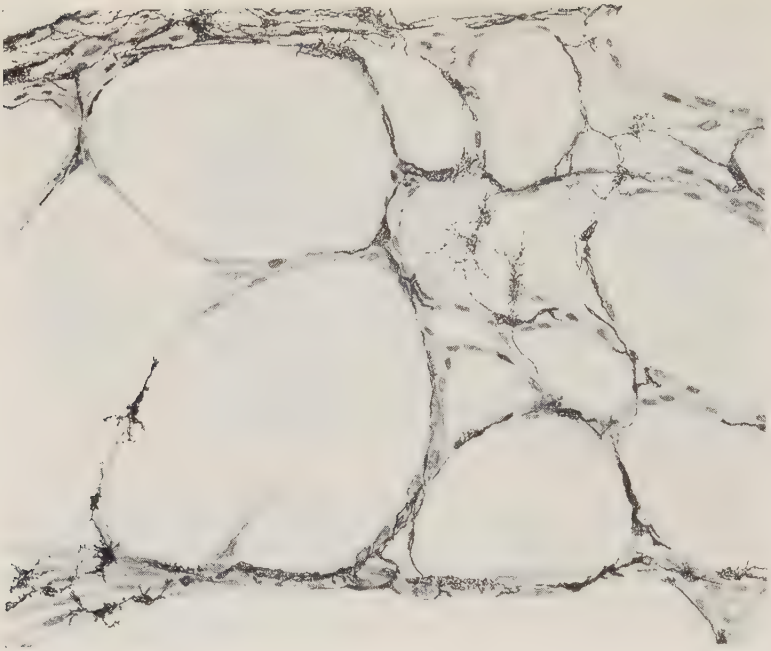

Figure 9

Hydropic larva (Pex 123) 19 days old. Melanophores creeping along muscle strands and connective tissue membranes 130×

Figure 10

Hydropic larva (Pex 122) 19 days old. Elongate melanophores attached to muscle strands 465×

Figure 11

Hydropic lerva (Pex 122) 19 days old. Flat and elongate melanophores attached to muscle strands connected by connective tissue membranes 310×

Figure 12
Hydropic larva (Pex 164) 18 days old. Elongate melanophores attached to connective tissue membrane 345×

Figure 13
Hydropic larva (Pex 22) 18 days old. Thread like melanophores on the edge of a flattened muscle strand 465×

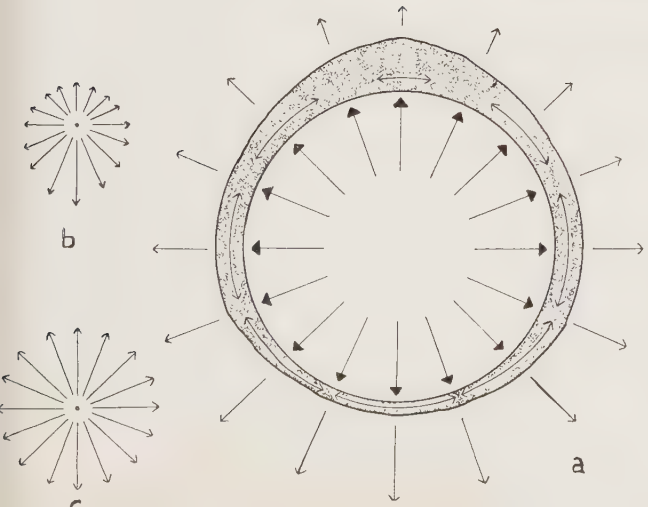

Figure 14
Scheme indicating the different amounts of pressure on the peritoneal wall of hydropic larva (Explanation in the text)

ON SOME PISTACIA APHIDS (HOMOPT., APHIDIDAE) FROM ISRAEL

D. Hille Ris Lambers

Bladluisonderzoek T.N.O., Bennekom

ABSTRACT

Baizongia pistaciae lives on grass-roots through the year in Central and Western Europe when *Pistacia* is absent. However, alatae from *Pistacia* still fly from the Mediterranean to Western Europe so that this is no case of an incomplete cycle caused by the local extinction of *Pistacia*, as suggested by Mordvilko. *Forda hirsuta* Mordvilko is a synonym of *Forda riccobonii* (Stefani). *Slavum wertheimae* nov. spec. is described. The biology of this non-migrating *Pistacia* aphid was earlier recorded by Mrs. G. Wertheim. The genus *Slavum* Mordv. is discovered.

Baizongia pistaciae (L.)

Fresh galls from *Pistacia palaestina* Boisd. collected near Jerusalem, 30.X.1953, by E. Swirski contained alatae on arrival at Bennekom. The alate fundatrigeniae produced larvae, which could not be reared on stolones of *Agropyrum repens* P.R. But roots of *Agrostis stolonifera* Koch appeared to be suitable food, though it appeared necessary to add some ants (*Lasius flavus* L.) to the tubes in which I reared the apterous exules. These exules were morphologically indistinguishable from apterae collected from roots of various Gramineae by I. Harpaz in Israel, and by me in the Netherlands.

It is not generally known that the exules occur also in Central and Western Europe. Theobald (1929) described them from England under the name *Tycheoides setariae* Pass., 1860, but his record from Porlock relates to a *Geoica* sp. Hille Ris Lambers (1944) records this species as *Tychea* or *Tetrenema* sp. from Borkum, Germany. I found it also rather commonly in my garden at Bennekom, Netherlands and from these started a culture in artificial ant nests with *Lasius flavus* on *Agrostis stolonifera*. In this culture on 1.IX.1953 a single alata developed; it was a morph which has not yet been recorded, an alate virginoparous exul; the morphology agrees with that given by Roberti (1939) for sexuparae, but the first tarsal joints are like those of apterous exules, with 3 instead of 4 hairs and the embryones in its abdomen have normal mouth-parts. It is therefore certain that this species lives anholocyclically in Western Europe and that it has means of dispersal accordingly.

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From Mordvilko's much quoted theories (e.g., 1935) it would seem that here we had a typical case where after the local extinction of *Pistacia* the species continued living anholocyclically on its secondary host plants. But as Hille Ris Lambers (1955) pointed out, the distance which alate aphids cover in flight has been underestimated. On 31.X.1953 an alate which by the structure of its anal plate unmistakably is a fundatrigenia from a gall on *Pistacia* was caught in a Moericke trap near Oirschot in the Netherlands, at the time when in the Mediterranean area alatae left those galls. This proves that the anholocyclically living population in the Netherlands is not at all deprived from contact with *Pistacia* since tertiary times. And one may safely assume that what holds for *Baizongia pistaciae* (L.) will also occur in other so called "anholocyclic species" of *Fordini* in Western and Central Europe.

Forda riccobonii (Stefani), 1899

Until now no data have been published about the cycle of this species which forms well known galls along the margins of the leaves of *Pistacia atlantica*. E. Swirski provided me in 1953 with fresh material of galls. Alatae were transferred to rhizomes of *Agropyrum repens*, where larvae were deposited. The larvae developed into the undescribed apterous exules, of which several generations developed in wide glass tubes closed with a cotton plug.

It appears that all the morphs — alate fundatrigeniae, their larval progeny and adult apterous exules — of *F. riccobonii* (Stef.) agree in every detail with the description and very good figures which Mordvilko (1935) gives for *Forda hirsuta* Mordv., 1935. Therefore there is no need to give a description of *F. riccobonii* (Stef.). *F. hirsuta* Mordv. obtained from galls on *Pistacia vera* in Turkestan and reared on *Agropyrum repens* may be listed as a synonym of *F. riccobonii* (Stef.). *Forda ussuriensis* Mordv., 1921 most probably also is a synonym of *F. riccobonii* (Stef.).

Slavum **wertheimae** n.sp.

Apterous viviparous female (fundatrigenia).

Morphological characters: Body roundish, about 1.20—1.45 mm long. Front convex, brownish, with paler membraneous median suture; small wax-glands present or absent near posterior margin laterally, sometimes frontally. Antennae of 5 segments; Vth about twice IIIrd, the latter about as long as IVth; primary rhinaria without distinct fringe, that on Vth with 4 accessory rhinaria; antennal hairs short, acute. Eyes of 3 facets. Rostrum reaching past the middle coxae; apical segment as long as 2nd joint of hind tarsi, with 2 hairs besides the 3 apical pairs (and besides the tension perceptor hairs). Pro-, meso- and metanotum and abd. tergites I—VII with spinal and marginal wax-glands, abd. segments I—VI besides with pleural wax-glands; the size of these glands varies from one cell (e.g., on the head) to some 45 cells in the transversely oval glands of VIIth abd. tergite, and

Figure 1
Slavaum wertheimae nov. spec.

often a gland is absent. Dorsal hairs of different length; cephalad the wax-glands usually one or two hairs which are much longer than the other hairs. Cauda with 4 hairs. First tarsal joints with 3 hairs.

Colour: Orange yellow.

Measurements (mm):

No.	Length body	Ant.	Ant. segments		
			III	IV	V
1	1.30	0.27	0.049	0.045	0.085
2	1.29	0.27	0.043	0.045	0.085
3	1.26	0.27	0.043	0.047	0.087

From *Pistacia*, Ain et Tine, N. of Damascus, Syria, 15.IX.1955, leg. F. Schneider.

Alate viviparous female (fundatrigenia = sexupara).

Morphological characters: Body elongated oval, with black sclerotic head and thorax and with the spinal wax-glands and sometimes small bands around and cephalad them faintly brownish pigmented. Front convex with shallow median furrow. Wax-glands on the head absent. Antennae of 6 segments or sometimes on one side 5 segments; of these the last is by far the longest, about $1\frac{1}{4}$—$1\frac{1}{2}$ times the IIIrd when 6 segments are present, but as long as IIIrd when 5 segments are present; segments III—V each with a subterminal, round, transversely oval or irregularly shaped rhinarium without a trace of a hairy fringe; last segment with a cluster of rhinaria consisting of a small, roundish primary rhinarium with perhaps a hairy fringe and probably always 4 accessory rhinaria with apparently a rudimentary hairy fringe. Rostrum with the last segment slightly more acute than in the preceding morph, about $\frac{2}{3}$ of the 2nd joint of the hind tarsi. Mesonotum with (in dorsal view) the praescutum not separated from the scutum by sutures, though in frontal view there are sutures more ventrad; rarely posterior part of the scutum with one or a pair of small spinal wax-glands; metanotum with distinct spinal wax-glands. Wings with the typical venation of the genus. Legs rather long, dark; first tarsal joints with usually 4 hairs — 2 long hairs and 2 short spines — but sometimes a joint with distinctly 3 hairs was found in a specimen; second tarsal joints rather long and slender, $\frac{1}{3}$ the length of the tibiae; empodial hairs exceptionally short, about half as long as the sclerite on which they are placed, seemingly absent. Abdomen with distinct pigmented strongly transverse spinal wax-glands from tergite I—VII, decreasing in size caudad and often on some tergites reduced to a few cells; marginal glands small, roundish, on tergites II—VII. Cauda with 4 hairs. Subgenital plate with a membraneous area below the anus, with some 20 dispersed, rather short, curved hairs with fine, undivided apices on the sclerotized part.

Colour: Head and thorax black, abdomen probably first yellow, later blackish green.

No.	Length body	Ant.	Ant. segments III	IV	V	VI
1	2.17	0.45	0.075	0.062	0.075	0.121
2	2.21	0.43	0.085	0.053	0.070	0.109
3	2.02	0.46	0.085	0.068	0.085	0.128
4	1.74	0.45	0.085	0.064	0.075	0.128
5	1.70	0.44	0.085	0.058	0.069	0.117
6	1.85	0.45	0.096	0.072	0.075	0.123

1–3, from *Pistacia atlantica* Desf., Jerusalem, Israel, IX.1949, leg. Wertheim.
4–6, from *Pistacia*, Ain et Tine, N. of Damascus, 15.IX.1955, leg. F. Schneider.

Measurements (mm):

Larvae.

(a) First instar larvae in the gall, presumably larvae I of sexuparae. Antennae of 4 segments, but IIIrd segment nearly always constricted in the middle; primary rhinaria on last segment distinctly ciliate, those on penultimate segment not ciliate. Rostrum rather long; last segment rather acute, with the proximal pair of the 3 subapical pairs at about $\frac{3}{5}$ from its base. Very small roundish wax-glands of only a few cells present in the same pattern as in the aptera vivipara, but more erratic. Empodial hairs short, slightly longer than the sclerite on which they are placed, dorso-apical hairs of 2nd tarsal joint about half as long as the joint.

(b) Embryones inside the sexuparae.

(1) Oviparous larvae. Antennae of 4 segments with the segments about equal in length. Wax-glands are present in very unusual arrangement; dorsally the pori are little smaller than a larval ommatidion and they lie rather far apart, strung out almost in irregular transverse lines on the abdomen, more in transverse groups on head and thorax; ventrally there are also transverse lines or double lines of pori, but these pori are much smaller than the dorsal ones, and they lie closer together in almost uninterrupted double rows. Dorso-apical hairs on 2nd tarsal joints about $\frac{2}{3}$ of the length of that joint.

(2) Male larvae. Antennae of 4 segments. Wax-glands of the type and arrangement as in apterous viviparous adults, but much smaller. Dorso-apical hairs of 2nd tarsal joints as in the preceding larva I.

Collecting data: *Pistacia atlantica*, Jerusalem, IX.1949, leg. Wertheim; *Pistacia*, Ain et Tine, north of Damascus, 15.IX.1955, leg. Schneider, cauliflower galls in the axils of the leaves. Apterae, larvae, sexuparous alatae and some larval progeny of the latter.

Discussion: It is with reluctance that I place this species in the genus *Slavum* Mordv., 1927, of which I have not seen the typus generis, *Slavum lentiscoides* Mordv., 1927. *Slavum* belongs to a group of Fordine genera which key as follows:

1(2) Wings flat in repose. All rhinaria with a fringe of hairs. Primary rhinarium on last antennal segment in all instars with one acessory rhinarium.

Aploneura Pass., 1863

2(1) Wings tectiform in repose. Secondary rhinaria not with a fringe of hairs. Primary rhinarium on last antennal segment in all instars with several accessory rhinaria.

3(4) In alatae all antennal segments with only one large rhinarium and last antennal segment about 1½ times as long as IIIrd.

Slavum Mordv., 1927

4(3) In alatae antennal segments III –IV (or V) with more than one rhinarium and last antennal segment about as long as IIIrd, or little longer.

Baizongia Rond., 1848

On the basis of this key our species should come in *Slavum* Mordv., but the question remains whether there are sufficient reasons to separate *Slavum* from *Baizongia*. According to Mordvilko (1935), alatae of *Slavum lentiscoides* have a hairy fringe around the primary rhinaria; he repeats this several times in his paper, and draws these hairs in his fig. 145. But Nevsky (1929), in his key to Fordine genera, distinguishes *Slavum* Mordv. from *Pemphigella* Tullgr. (= *Baizongia* Rond.) by the absence of a hairy fringe around the rhinaria on VIth ant. segment in *Slavum*!

All alatae in the two samples contain only larvae without mouth parts, and also the wax-glands of several of these larvae show that they would have developed into oviparous females. This fully confirms what Wertheim (1954, 1955) wrote about the biology; the species does not migrate as other *Fordini*, but completes its cycle on *Pistacia*. The larvae born from alatae from galls, which Mordvilko (1935) describes and figures, would develop into viviparae. On this basis, and on the basis of the very different shape of the galls, I venture to describe the species as new. *Slavum lentiscoides* Mordv. must be very similar, but the figure of the alate which Mordvilko (1935, fig. 144) gives shows a well separated praescutum on the mesothorax. Nothing like this is present in *S. wertheimae* n.sp.

The species is named after Mrs. Guta Wertheim of The Hebrew University of Jerusalem.

Types: In the author's collection.

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THE HYBRID OF *BARBUS LONGICEPS* C.V. AND *VARICORHINUS DAMASCINUS* C.V. (CYPRINIDAE, TELEOSTEI)*,**

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ABSTRACT

(1) In the lakes of Israel a Cyprinid fish resembling both *Barbus longiceps* and *Varicorhinu damascinus* is occasionally caught; these latter species are abundant in the same lakes

(2) As a first step in defining the standing of the problematic fish, *Barbus longiceps* and *Varicorhinus damascinus* are compared with each other regarding general body structure and a number of special characters, some of which are subjected to statistical analysis.

(3) In the following stage the fish in question is studied with regard to the same aspects as the two species mentioned. Comparing then the three kinds of fishes it is found that in every character in which *Barbus longiceps* and *Varicorhinus damascinus* differ morphologically from one another in a clear fashion, or significantly in the statistical sense, the fish in question exhibits an obvious intermediacy between the species mentioned. This intermediate position is further analysed from a statistical point of view.

(4) It is suggested that the fish studied is a cross between *Barbus longiceps* and *Varicorhinus damascinus*.

(5) Ecological considerations explain the probability of the two cyprinid species producing hybrid progeny.

(6) Artificial crossfertilization (by Dr. H. Mendelssohn) has verified the hybrid character of the fish studied.

(7) It is shown that the natural hybrid population represents in all probability more than the F_1 generation of the cross.

Many years ago local fishermen drew our attention to a large kind of Cyprinid fish which was occasionally caught in Lakes Tiberias and Hula. There are only three larger species of Cyprinids in the whole Jordan System (Steinitz 1953), *Barbus longiceps* C.V., *Barbus canis* C.V. and *Varicorhinus damascinus* C.V. They are regularly caught and easily discerned on first sight. The rare kind mentioned is soon singled

* The recent paper by Hubbs (1955) offering a review of problems of fish hybrids could not be taken into consideration. It came to our attention when the manuscript of this paper was concluded.

** Thanks are due to Drs. E. Goldschmidt and W. Koch for critical remarks. Miss H. Stettiner helped considerably in computing statistical data and drawing the graphs.

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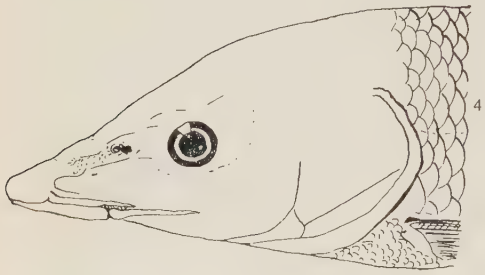
but from the three others. It has no similarity to *B. canis* but, though different from both *B. longiceps* and *V. damascinus*, it exhibits specific features of both these latter fishes. In spite of the close taxonomic relationship existing between the genera of *Barbus* and *Varicorhinus*, *B. longiceps* and *V. damascinus* represent types that can be distinguished most readily by external features (Figures 1 and 2).

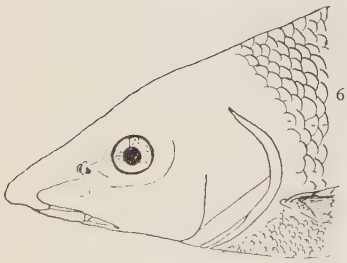
B.l. has larger scales, a larger head and a larger snout than *V.d.* Also, the configur-

Figures 1—3

1. *Barbus longiceps*, 345 mm standard length (fresh specimen). 2. *Varicorhinus damascinus*, 365 mm standard length (fresh specimen). 3. Hybrid fish, 230 mm standard length (1055) (specimen preserved in formalin).

ation of the head and mouth and the position of the latter are utterly different. The short head of *V.d.* (Figure 5) has the dorsal profile evently descending towards the tip of the snout, while the long head of *B.l.* (Figure 4) has its profile descending less steeply from its posterior end to behind the eye level; from that point it bends down towards the anterior end; a slight concavity is always found in the nasal or prenasal part of the dorsal profile. The interorbital width is much larger in *V.d.* than in *B.l.* Observed from the ventral side, the heads of the two species are equally well distinguished. The width of the head decreases more or less evenly from the opercular border to the mouth in *V.d.* (Figure 8). From that point on, it narrows more strongly towards the projecting end of the snout. The wide mouth is set almost



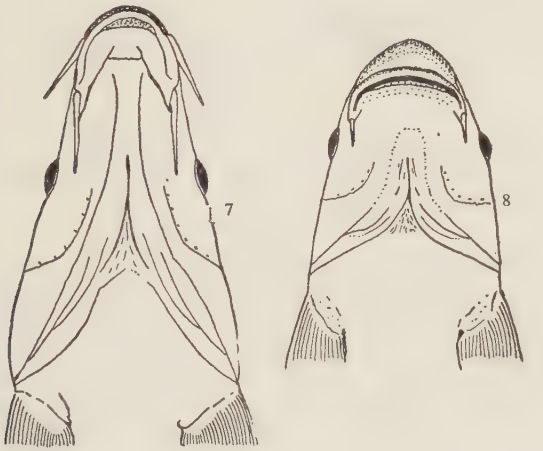


Figures 4—6
Side view of head of (4) *Barbus longiceps* (694)*, (5) *Varicorhinus damascinus* (696), (6) Hybrid (724).

* Only adult specimens have been figured. Numbers in brackets indicate catalogue number in the collection of the Sea Fisheries Research Station, Haifa. All drawings by A. Ben-Tuvia.

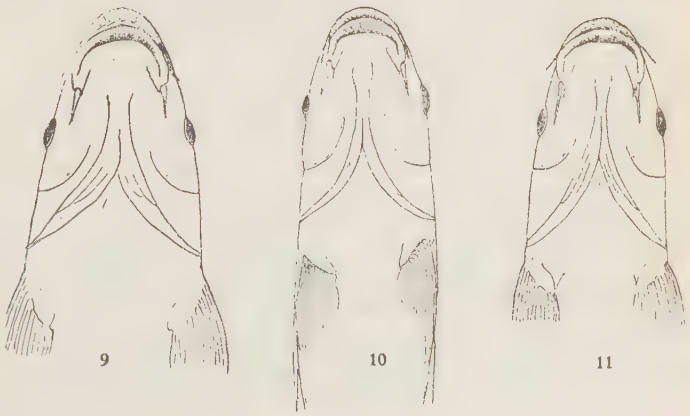
squarely, considerably posterior to the snout tip. In *B.l.* (Figure 7), the head narrows strongly between the opercular border and the eye level. From there on, however,

it is drawn out into an elongated snout of only slightly decreasing width. The strongly rounded mouth lies only a little behind the tip of the snout. *V.d.* possesses one pair of short barbels originating from the outer and hind corner of the mouth region, while *B.l.* owns two larger pairs, of which the anterior, slightly shorter, is rooted in the rostral part of the upper lip, the posterior, longer one, in a place comparable with that of the origin of the barbel of *V.d.* The lower jaw of *V.d.* has the sharp, hard edge typical for the genus. *B.l.* lacks an edge on its lower jaw. More distinguishing features with regard to the head and its parts may be appreciated upon studying Figures 4, 5, 7 and 8.



Figures 7—8
Ventral view of head of (7) *Barbus longiceps* (694), (8) *Varicorhinus damascinus* (696).

Vertical fins as well as paired ones do not significantly differ in the two species as regards the number of composing elements. However, there is a clear distinction as to the relative position of the D and V fins. While the V fin of *B.l.* originates close to the level of the origin of the D fin, the V fin of *V.d.* originates considerably behind the D fin. *V.d.* possesses an elongated scale on the outer side of the V fin base. *B.l.* lacks such a scale.



Figures 9—11
Ventral view of head of (9) hybrid (724), (10) hybrid (725), (11) hybrid (726).

There are also great differences in structure and dentition of the lower pharyngeal bones. Those of *B.l.* (Figures 12 and 15) are relatively heavily built, broad, but more smoothly curved. The innermost tooth of the first row is distinguished by its large dimensions. In *V.d.* (Figures 13 and 16) the lower pharyngeal is of more slender build, but more sharply bent. The innermost tooth of the first row is not disproportionate.

Figures 12—14
Front view of lower pharyngeal bone of (12) *Barbus longiceps*, (13) *Varicorhinus damascinus*, (14) Hybrid.

The peritoneal covering is transparent in *B.l.*, but black in *V.d.*

Inspection of the supposed hybrid with regard to external characters demonstrates extensive variability on their side. The dorsal profile of the head (Figure 6) almost evenly descends in most of the specimens, but a slight indication of the postocular bend, so characteristic of *B.l.*, can be observed. Similarly, the shallow concavity in

Figures 15—17
Side view of lower pharyngeal bone of (15) *Barbus longiceps*, (16) *Varicorhinus damascinus*, (17) Hybrid.

the nasal section of the profile is just perceptible. Figure 9 illustrates the variability of features in the ventral view of the head. In no case have we found the broad widening of the opercular region nor the drawn-in eye level with the snout region drawn out like that of *B.l.* In this view the hybrids are more similar to *V.d.* than to *B.l.*, although there are several characters pointing more to the latter. The mouth is rounded, if less than in *B.l.* Conversely, the preoral region is shorter than in *V.d.* A large majority of specimens (17 out of 19 examined) had two pairs of barbels in the position described above for *B.l.;* one specimen had the posterior pair only, and in one specimen the anterior barbel was present on one side only while the posterior barbels were paired. The lower jaw is more arched and more prominently

bent caudally on both sides. An edge is present but not as sharp nor as strongly cornified as in *V.d.*

The origin of the V fin is posterior to that of the D fin, a character which strengthens the hybrid's similarity to *V.d.* Another character common to the hybrid and *V.d.* is the presence of the enlarged scale on the external side of the V fin, but in the hybrid fish the scale is less developed than in *V.d.*

The lower pharyngeal of the hybrid (Figures 14 and 17) is not as slender as in *V.d.*, nor is it as broad as in *B.l.* It is bent almost as much as that of *V.d.* The pharyngeal teeth vary widely with regard to shape and arrangement. In most of the individuals we examined they were more similar to those of *V.d.*, but always the tooth corresponding to the large one of *B.l.*, was indicated as at least slightly outstanding in size.

In almost all of the hybrid fishes examined internally, the peritoneal covering was black like that of *V.d.*

In conclusion, the evaluation of the characters mentioned so far not only confirms the view that the fish studied is structurally a hybrid of characters of both *B.l.* and *V.d.*, but it furthermore suggests that the hybrid tends on the whole more towards *V.d.* In an attempt to ascertain whether this view is more than a first impression, we examined more closely meristic characters, counts and body proportions, and subjected several of them to statistical analysis*.

In the first instance the supposed parent species must be compared. The dorsal fin of 30 specimens of *B.l.* shows the following counts: 2/8, 3/8, 3/9, 4/7, 4/8, with the highest frequency in 4/8 (15 specimens). The same fin of 7 specimens of *V.d.* shows counts of 2/8, 2/9, 3/8, 3/9, 4/9. The anal fin of 28 specimens of *B.l.* has counts of 1/5, 1/6, 2/5, 2/6 with an obvious preference for 2/6 (20 specimens), while that of 7 *V.d.* specimens has counts of 1/5, 2/5, 2/6, 3/6. We have abstained from analysing these counts more fully. The scale counts of the lateral line as well as of the transversal line were studied in detail. As shown in Table I, the range of lateral line scales of *B.l.* is rather wide, leaving a gap of 7 scales between the highest count of the large scaled *B.l.* and the lowest count of the smaller scaled *V.d.* The difference of means (18.1 scales) is highly significant (Table II). A similar result is obtained when the transversal line counts of the two species are compared. Here, too, there is no overlap in counts, ranges being 5 scales apart. Although a small sample of four *V.d.* only was available for study, the difference of means, amounting to 9.3 scales, was of considerable significance (Table II). Among the body indices treated there are a few requiring

* In rendering the results of our calculations we thought it useful to give besides the tables of numerical values a graphical representation which has a number of advantages fully explained by the authors of the particular method applied here. Hubbs and Hubbs (1953) improved the shortcomings of the original method suggested earlier by Hubbs and Perlmutter (1942). The horizontal base line of each bar indicates the range of variation; on it the mean is shown by a vertical line sticking out from the black bar. The hollow bar indicates the value of σ (standard deviation; see footnote on p. 179) on either side of the mean while the black bar indicates the value of $2\sigma M$, (standard error) on either side of the mean. Pointing out the advantages of the graphical representation of these parameters, the authors show conclusively that with regard to the black bars ($2\sigma M$) "considerable reliance can be placed on the significance of the difference between samples, if the corresponding rectangles are only slightly separated, or if the overlap is not more than about 33 per cent of the length of the shorter of the two rectangles. . . ." By this method, then, comparative inspection of the length of corresponding bars as related to the rate of their overlap or separation, is used as a means for judging the significance of the difference between samples. For details of the method and its evaluation reference should be made to the papers mentioned. The authors conclude that graphs of this kind may be exploited with a fair degree of accuracy as to the value of significance (which is otherwise computed (t-test) and presented in Table II).

TABLE I

Comparison of indices and numerical characters of the parent species and the hybrid fish. σ_M standard error; σ_c standard deviation. Compare graph, Figure* 18.

	Standard length/Head			Head/Interorbital			Head/Snout			Head/Posterior barbel		
	B.	H.	*V.*	*B.*	H.	*V.*	*B.*	H.	*V.*	*B.*	H.	*V.*
Range	3.0—4.0	3.5—5.3	4.1—5.1	3.0—4.3	2.3—3.4	2.1—2.5	2.3—2.7	2.4—3.1	2.3—3.0	3.6—5.2	5.3—8.1	6.5—8.2
N	29	19	10	21	19	7	21	19	7	7	9	4
Means	3.483	4.290	4.610	3.367	2.679	2.271	2.491	2.590	2.800	4.300	6.311	7.475
σ_M	0.046	0.081	0.101	0.058	0.068	0.048	0.024	0.042	0.093	0.193	0.264	0.326
σ_c	0.249	0.351	0.318	0.267	0.298	0.126	0.109	0.182	0.245	0.552	0.841	0.751

	Head/Anterior barbel			Head/Eye			Transversal line			Lateral line		
	B.	H.	*V.*	*B.*	H.	*V.*	*B.*	H.	*V.*	*B.*	H.	*V.*
Range	4.2—5.2	6.5—9.3	—	5.3—7.3**	4.7—7.2	5.2—7.6	18—20	19—26	25—32	51—60	53—78	67—82
N	7	8	—	21	19	9	23	19	4	29	19	10
Means	4.771	7.725	—	6.165	5.416	6.000	19.000	23.842	28.250	55.724	66.316	73.800
σ_M	0.129	0.311	—	0.133	0.152	0.264	0.126	0.684	1.493	0.384	1.078	1.571
σ_c	0.368	0.939	—	0.625	0.662	0.792	0.605	2.652	2.987	2.086	4.829	4.967

* In this paper σ_c is used throughout, obtained by multiplying σ by $\sqrt{\{n/(N-1)\}}$; this correction, suggested by Hill, gives a more reliable estimate for small samples (number of observations less than 30).

** Reduced range, see text p. 180

TABLE II

Significance of difference of means of characters presented in Table I (t-test). Compare with graph, Figure 18. $n = N_1+N_2-2$. *Abbreviations of charaters as in Figure* 18.

	B.l.—*V.d.*		*B.l.*—Hy.		*V.d.*—Hy.	
	n	*t*	*n*	*t*	*n*	*t*
STL/H	37	11.484	46	9.292	27	2.406
H/IO	26	10.296	38	7.680	24	3.484
H/SN	26	4.672	38	2.116	24	2.343
H/PB	9	8.086	14	5.542	11	2.369
H/AB	—	—	13	7.788	—	—
H/E	28	0.611	38	3.687	26	2.043
TR.L	25	14.431	40	8.502	21	7.263
L.L	37	16.119	46	10.455	27	3.935

special remarks. It has been noted above that *B.l.* has two pairs of barbels of which the posterior one is the counterpart of the single pair which is owned by *V.d.* Apart from the fact that it is not easy to establish the basal point of the barbel, and that, therefore, measurements are not as certain as desirable, we also concluded from certain irregularities of shape that barbels are likely to become injured and may, then, regenerate to a naturally uncontrollable degree. As a precaution we have used only individuals in which right- and left-side barbels were not conspicuously different. Seven fishes of *B.l.* are available for this purpose, and only four of *V.d.* It can be seen (Table I) that the index ranges of the two species are wide apart. As far as can be learnt from samples as small as ours, the means of the indices of the species would be significantly different.

Other difficulties are encountered in making use of the head-eye index. Incidentally, of all the indices studied, this is the only one which seems to be correlated to growth in *B.l.*: if the 28 individuals are arranged in 10 size groups between 111 mm and 460 mm standard length, a decrease in eye diameter (as related to head length) with increasing standard length is noted. Nothing of the kind can be observed in *V.d.** Simple comparison of data of the two species is thus made difficult. Grouping in length classes would not have been of much help, since thereby sample size would become too much reduced. In order to avoid extreme values, we excluded from our calculation the smallest and the largest specimens of *B.l.* Thus, we obtained for comparison two groups consisting of 21 *B.l.* ranging from 187 mm to 318 mm standard length, and 9 *V.d.* ranging from 212 mm to 313 mm standard length. Indices in both groups are almost identical; the small difference of means is far below the level of significance. The head-eye index is therefore of no use in differentiating the species in question.

* Although it is important that in all the other body proportions studied in *B.l.* a correlation with body size was absent and that no such correlation was indicated anywhere in *V.d.* nor in the hybrid, no generalization should be drawn from this. Such a procedure would not take account of the fact that the standard lengths of individuals dealt with here were lower than 113 mm in *B.l.*, 212 mm in *V.d.*, and 210 mm in the hybrid fish.

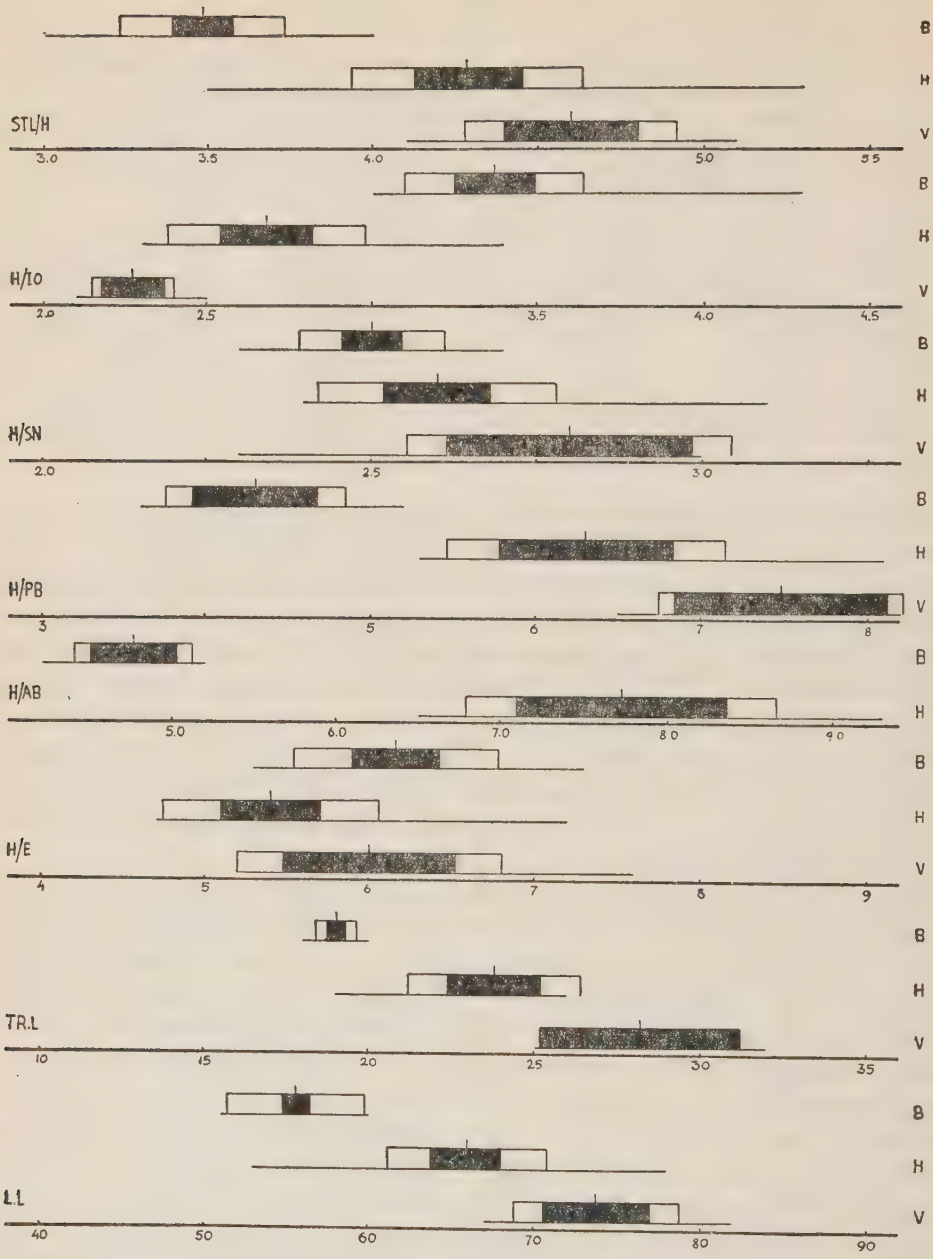


Figure 18

Range, means, standard error and standard deviation of several characters of the parent species and of the hybrid. For explanation of graphical presentation see footnote to page 178. ABBREVIATIONS: B, H, V on right side of graph: *Barbus longiceps*, Hybrid, and *Varicorhinus damascinus*, respectively. STL/H — standard length/head; H/IO — head/interorbital width; H/SN — head/snout; H/PB — head/posterior barbel; H/AB — head/anterior barbel; H/E — head/eye; TR.L — scales in transversal line; L.L — scales in lateral line.

The remainder of the indices applied, namely standard length-head, head-snout and head-interorbital distance, are all distinguished by a highly significant specific difference of their means (Table II).

Comparing now the hybrid fish with both the parent species, only those characters will be dealt with in which the parents differ significantly from each other.

Lateral line counts of 19 fishes at once show the variability characteristic of the hybrids. Whereas the scale counts of the parent species vary about 17.6% and 22.4%, respectively, those of the cross vary about 47.2%, thereby not only ingressing the ranges of the parents, but even covering them almost entirely. The mean, however, although much nearer to that of *V.d.*, is very significantly different from that of both *B.l.* and *V.d.*

As to the transversal line counts, variability at 36.9% has also greatly increased in the hybrid, even above that of *V.d.* (28.0%). On the other hand, overlapping of ranges is less extreme than in the longitudinal scale counts. Here, too, the significance of the mean difference of the hybrid and parents counts is considerable.

The index of standard length and head shows another peculiarity in the hybrid fish. As in the preceding characters, at 51.4% variability it exceeds conspicuously that of the parents (33.3 and 24.2%); but it also exceeds the absolute maximum index of *V.d.*, 5.1, reaching its own maximum at 5.3. Its minimum value lies at the middle of the range of *B.l.* The mean value, far apart from that of *B.l.* and well outside the latter's total range, is much nearer to the mean value of *V.d.* and, as a matter of fact, well within the latter's total range. Still, the *t*-test proves it to be significantly different even from the mean of *V.d.*

The interrelations of the hybrid with the parents appear still more intricate when the head-snout index is considered. Although ranges start at the same minimum value, variability in *V.d.* is much higher than in *B.l.* (30.4 and 17.4%, respectively), but it seems not at all increased in the hybrid (29.2%). Contrary to what was seen previously, the mean value of the hybrid is closer to that of *B.l.* than to that of *V.d.* It was to be expected from the broad overlap of ranges and the distribution of individual indices, that no high significance would distinguish the means of the hybrid as compared with those of the parents. Calculation of *t* resulted in figures just above the level of significance for the 5% probability.

The head-interorbital index corresponds to the majority of factors considered hitherto. As in the majority of the characters mentioned so far, the variability exceeds that of the parents (47.8% in the hybrid; 43.3% in *B.l.;* 19.1% in *V.d.*). Overlap of ranges is reduced and the means are widely separated, that of the hybrid being nearer to *V.d.* than to *B.l.* There is a clear significance in the difference of means of the hybrid and of *V.d.*, but it is much greater when related to that of *B.l.*

Numerous intergeneric hybrids of Cyprinidae have been described. It is, therefore, not surprising that crossing of species of *Barbus* and *Varicorhinus*, two very closely allied genera, should occur whenever ecological conditions are in favour of cross-breeding. Regarding conditions prevailing in natural biotopes during the breeding

season of the species involved, the following facts must be kept in mind. Shoals of *B.l.* as well as of *V.d.* can be seen entering wadis falling into Lakes Tiberias and Hula when the rainy season is on and water is running high in brooks and streamlets draining the mountain slopes of the area. Coarse and fine gravel and larger stones make for an uneven bed of the wadis and cause the cool water to mix thoroughly with air. *Acanthobrama* and *Phoxinellus kervillei* have been found in the Hula district joining the up-stream move of *B.l.* and *V.d.* Upon examination of the bottom of wadis in which fishes had been observed moving up-hill, fish eggs can be recovered from between stones where they had settled, and can be found sticking to the surface of stones and gravel, in accord with the spawning habits of the respective species. Eggs collected from these sites have repeatedly been kept for study; they are mostly fertilized and develop normally. Since the anadromous shoals are composed of several species and the spawning sites are used jointly, there can be little doubt that chances of eggs of *B.l.* and *V.d.* becoming fertilized, while exposed to the strong current, by spermatozoa of either species, are marked. Dr. H. Mendelssohn, to whom we are indebted for the permission to use certain of his observations, obtained from eggs collected from localities just mentioned fry of *Acanthobrama*, *Phoxinellus*, *Barbus longiceps*, and *Varicorhinus damascinus*, but also specimens of the fish suspected to be the hybrid of the last two species. In an attempt to provide final proof of the hybrid character of the fish described here, Dr. Mendelssohn recently fertilized eggs of *V.d.* with sperm of *B.l.* obtained by means commonly applied in artificial fertilization. Development was normal and at 12 months' age the largest among the offspring were approximately 78 mm long. No test has so far been made of the possibility of the reciprocal cross. Neither is there experimental evidence of the possibility of interbreeding of the F_1 hybrids nor of that of the backcrosses and their respective viability*. Experiments on these lines would be a valuable aid for a more detailed investigation of the natural hybrid population. Questions pointing

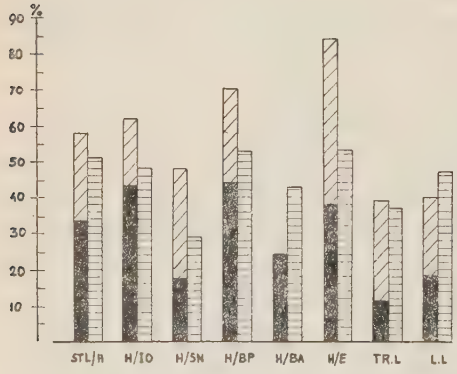


Figure 19

Graphical presentation of variability of characters of parent species and hybrid. Each pair of columns indicates the variability of the character in *Barbus longiceps* and in *Varicorhinus damascinus* superimposed upon each other on the left, and that in the hybrid on the right. *Barbus longiceps* black, *Varicorhinus damascinus* diagonally hatched, hybrid horizontally hatched. For numerical information see Table III. ABBREVIATIONS: H/BP — head/posterior barbel; H/BA — head/anterior barbel. Other abbreviations as in Figure 18.

* That hybrid females may be fertile is at least made probable by the following observation. A female hybrid of 313 mm standard length (No. 723) and of 580 g total weight contained an ovary of 92.5 g. Concluding from a sample portion of the ovary, the whole organ was found to contain 14,740 eggs, of which 11,610 were considered to have attained full size (maturation stage IV), although slight pressure on the belly of the fish had not caused release of eggs (stage V).

TABLE III

Range, difference of maximum and minimum (d), and variability (v) of same characters as tabulated above (Table I). For definition of variability see footnote, p. 183. Abbreviations of characters as in Figure 18.

		N	Range	*d*	*v*
STL/H	*B.l.*	29	3.0—4.0	1.0	33.3
	Hy.	19	3.5—5.3	1.8	51.4
	V.d.	10	4.1—5.1	1.0	24.4
H/IO	*B.l.*	21	3.0—4.3	1.3	43.3
	Hy.	19	2.3—3.4	1.1	47.8
	V.d.	7	2.1—2.5	0.4	19.0
H/SN	*B.l.*	21	2.3—2.7	0.4	17.4
	Hy.	19	2.4—3.1	0.7	29.2
	V.d.	7	2.3—3.0	0.7	30.4
H/PB	*B.l.*	7	3.6—5.2	1.6	44.4
	Hy.	9	5.3—8.1	2.8	52.8
	V.d.	4	6.5—8.2	1.7	26.1
H/AB	*B.l.*	7	4.2—5.2	1.0	23.8
	Hy.	8	6.5—9.3	2.8	43.1
H/E	*B.l.*	21	5.3—7.3*	2.0	37.7
	Hy.	19	4.7—7.2	2.5	53.2
	V.d.	9	5.2—7.6	2.4	46.2
TR.L	*B.l.*	23	18 — 20	2.0	11.1
	Hy.	19	19 — 26	7.0	36.9
	V.d.	4	25 — 32	7.0	28.0
L.L	*B.l.*	29	51 — 60	9.0	17.6
	Hy.	19	53 — 78	25	47.2
	V.d.	10	67 — 82	15	22.4

in this direction are also suggested by the statistical account given in this paper. Two of them may be taken up here briefly as particularly prominent.

The eight structural characters treated statistically can be compared in their variability** (see Table III and Figure 19). Comparing first the variability of the parent species, four characters are more variable in *V.d.* than in *B.l.* In three characters, the standard length-height index, the head-interorbital index, and the head-post.barbel index, *B.l.* exceeds *V.d.* in variability. As to the variability of characters in crosses, this has frequently been studied in relation to that of the parents. While in the F_1 generation variability is more or less the same as in the parents, it increases in subsequent generations. Calculating the hybrid variability we find it advanced

* Reduced range, see text p. 180

** Variability as used in this paper is the percent ratio of the difference between maximum and minimum values (range) in the minimum value; see Table III and graph, Figure 19.

beyond that of each of the parents in six out of the eight characters studied*,**. In two characters, namely the transversal line count and the standard length-head index, the variability of the hybrid even approaches the sum of that of the parent species, and in one, the lateral line count, it exceeds this sum. Although the narrow base of our analysis does not permit of far-reaching conclusions, the sample of hybrids actually studied is suspected of representing more than merely the F_1 generation of hybrids.

A few remarks are in order concerning the similarity of the hybrid or its position with reference to the parent species. Six of the characters treated statistically are available for this purpose. Supposing that the position of the mean of the hybrid character in relation to the means of the parents is indicative of tendencies, it is seen (Table I and Figure 18) that in five out of six characters the hybrid's tendency is towards *V.d.* This is very obvious regarding four characters, while it is just appreciable with regard to the fifth character, the transversal line count. The one character not in line with the above is the head-snout index. The overwhelming tendency of numerical characters of the hybrid towards *V.d.* is shared by several other features. Details of the head configuration have been recorded in this respect earlier in the present paper. Also, the position of the D fin and the large scale beside the V fin have been mentioned in this connection. In addition, the lower pharyngeal bone and its dentition tend towards *V.d.* in a definite manner. Finally, the black peritoneal lining draws the hybrid closer to *V.d.* Opposed to this striking combination of *Varicorhinus*-like characters on the hybrid's side are solely the head-snout index and the lack of an anterior pair of barbels, the absence of the latter being common to most of the hybrids and to *B.l.*

Considerations as these, referring to the intermediate position and to similarity tendencies of the hybrid, cannot replace the investigation of its genetic constitution. At best they indicate a few of the problems which are worth studying from the point of view of genetics. The understanding of the natural hybrid population would be greatly advanced by such a study, and its feasibility has lately been made clear by the demonstration of simple means for obtaining and keeping normal hybrids under artificial conditions (oral communication from Dr. Mendelssohn).

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* This is also the case with regard to the three indices which have been shown to vary more in *B.l.* than in *V.d.*

** Since the anterior barbel is not present in *V.d.*, the head-ant.barbel index can be evaluated in one direction only. The result shows that in the hybrid this character varies far more in than *B.l.*

ON THE ECHINODERM FAUNA OF HAIFA BAY

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ABSTRACT

A number of Echinoderms were collected in Haifa Bay, belonging to 24 species, five of which (3 starfish and 2 urchins) were previously unknown along the coast of Israel. They are mainly littoral and Mediterranean forms, chiefly living in sand or mud.

The study of 30 species of Echinoderms (Tortonese 1953—54) still left some problems of this fauna unsettled. A welcome opportunity of improving our knowledge was provided by E. Gottlieb of the Sea Fisheries Research Station, Haifa, who recently collected some very good material in Haifa Bay.

The new material confirmed the three points emphasized previously: (1) rather poor development of the Echinoderm fauna along the easternmost Mediterranean shores; (2) prevalence of species living in sand or mud, and (3) spreading of species migrating from the Red Sea. The bulk of this Echinoderm population is made up of Ophiurans and Spatangoids.

Species collected hitherto unknown to this area:

Luidia sarsi
Echinaster sepositus
Coscinasterias tenuispina
Stylocidaris affinis
Plagiobrissus costae

The distribution of these Echinoderms now becomes more fully understood, and it may be safely stated to include the whole Mediterranean.

The present material consists mainly of small or very small specimens. It seems that this dwarf condition is not due to the youth of the specimens but, as previously suggested (loc. cit.), the Echinoderms along the Israel coast develop poorly owing to unfavourable conditions in this extreme area of their habitat. *Antedon mediterranea* and *Amphiura chiajei* are good examples.

Specimens were collected from July 23, 1953 to September 27, 1955 at 10—55 fathoms in Haifa Bay (Lat. 32°50′ N). Dredge or grab were used. Twenty-four species were recorded. The serial number of samples (S) and depth in fathoms (F) are indicated for each species.

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CRINOIDEA

Antedon mediterranea (Lam.)

S. 209,202. F. 21,38.

ASTEROIDEA

Astropecten irregularis pentacanthus (D. Ch.)

S. 127,151. F. 21,27.

Astropecten aranciacus (L.)

S. 95,151. F. 16,21.

Some distal parts of arms, with well developed superomarginal spines, very probably belong to this species, which is known from Rhodes, Syria and Egypt; Bodenheimer (1935) recorded it also from Palestine.

Astropecten sp.

S. 56,130,133,220,223. F. 10—28.

Very young specimens.

Luidia sarsi Düb. Kor.

S. 213,239. F. 21,28.

Some fragments of arms (distal parts), which show three main adambulacral spines and three on the infero-marginal plates. I therefore refer them to *L. sarsi*, which is new for this area. Indeed, as far as I know, the genus *Luidia* has never been recorded east of Rhodes, where I found *L. ciliaris* (Phil.) (Tortonese 1946). It should be pointed out that *L. sarsi* does not always have three infero-marginal spines, as stated by Koehler (1924), in contrast to *L. ciliaris*, because in material from Naples I often notice four such spines on the proximal half of the arms.

Asterina gibbosa (Penn.)

S. 145. F. 10.

A single specimen, small and abnormal. Of its eight arms, two are much larger (*R* 7 mm) than the others, which are evidently regenerated.

Echinaster sepositus (Retz.)

S. 191. F. 43.

This single specimen is small (*R* 9 mm) and with unequal arms, of which three are regenerated. It is, however, one of the most interesting discoveries in Haifa Bay, as it proves that this well known Mediterranean Asteroid actually reaches the easternmost shores of this sea. As it has been reported from Rhodes and Cyprus, its presence in Egypt, where it is unknown, can scarcely be doubted. Perhaps this species is rare near these regions.

Coscinasterias tenuispina (Lam.)

S. 243. F. 18.

This starfish also is new for the fauna of Israel. It was reported from Rhodes and Egypt, so its presence in Israel was to be expected. The single specimen collected in Haifa Bay has six arms (broken), of which three are regenerated; in the longest *R* is about 22 mm.

OPHIUROIDEA

Ophiothrix fragilis (Abildg.)

S. 84,98,169,182,213,273. F. 10—40.

Ophiactis savignyi Müll. Trosch.

S. 98,105,112,129,170,186,190,200,202,241,245,260. F. 12—45.

This immigrant from the Red Sea is abundant all along the coast of Israel, and I already had it from the neighbourhood of Haifa (1954, p. 50).

Amphiura chiajei Forb.

S. 130,163,191,197,200,234,240,247,278. F. 13—43.

Amphiura mediterranea Lym.

S. 239. F. 28.

Amphipholis squamata (D. Ch.)

S. 99,110,216,266. F. 13,15,21,48.

Ophiopsila aranea Forb.

S. 56,71,96,152,169,180,200,211,233,239,240,256,257,263. F. 10—31.

This pretty Ophiuroid is very abundant in the sea of Israel.

Ophioderma longicaudum (Retz.)

S. 98. F. 12.

Ophiura texturata Lam.

S. 95,151,152,165,263. F. 16—31.

Ophiura grubei Hell.

S. 94,116,119,208,209,213,216,217,219,222,224,225. F. 10—30.

This material gives new evidence of the rich population of this tiny species in the Israel region, on sandy-muddy bottoms. Many specimens at hand are very small or in bad condition, so it is not certain whether all of them really belong to *O. grubei; O. albida* Forb. may be present, too.

ECHINOIDEA

Stylocidaris affinis (Phil.)

S. 103,277. F. 21,50.

A few small specimens and some isolated primary spines. This Echinoid is a fine novelty for the fauna of Israel; it is known from Rhodes and Egypt.

Genocidaris maculata A. Ag.

S. 132,182,239. F. 15,28,40.

Paracentrotus lividus (Lam.)

S. 98,169,239,272. F. 12—28.

In all these small specimens, few in number, the primary spines are lightly coloured.

Echinocyamus pusillus (O. F. Müll.)

S. 103,121,191. F. 21—43.

Echinocardium cordatum (Penn.)

S. 99,115,209,217,222. F. 13—21.

The largest specimen is only 22 mm long. Many very young (often crushed) specimens were collected and a part of them may belong to *E. mediterraneum* Forb., which in my previous report (1954, p. 63) was recorded from different localities in Israel.

Schizaster canaliferus (Lam.)

S. 199. F. 30.

Plagiobrissus costae (Gasco)

S. 215,242. F. 16.5,18.

Both the captured specimens are small (10—20.5 mm long) and whitish (in alcohol). The discovery of this Spatangoid in Haifa Bay is interesting, as it is known from few localities only, among which is Alexandria, where it was found by Mortensen and Steuer (1937). Its distribution includes the eastern Atlantic from Gibraltar to St. Helena. Recorded depth: 25—200 m.

HOLOTHURIOIDEA

Some very small representatives of this class were dredged (S. 73,112,225) but, as their identification is quite uncertain, no species can be listed here.

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SIPUNCULOIDEA FROM THE COAST OF ISRAEL

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The fauna of the eastern part of the Mediterranean has been only little studied in contrast to that of the western and central parts and of the Red Sea; as regards the three different groups Echiuroidea, Sipunculoidea and Priapuloidea, which are not at all interrelated, but for practical reasons still treated as a unit, they have never been subjected to a separate treatment. Finds of *Gephyrea* off the coast of Israel have not been hitherto recorded.

The present material deals with representatives of three species of the Sipunculidae. It comprises samples* from Caesarea and Appolonia, and also three samples labelled "Mediterranean Sea" without further specification. It includes 15 samples of *Phascolosoma*** *granulatum* Leuck., with about 80 specimens, *Aspidosiphon elegans* Cham. Eysenh., 2 specimens, and *A. mülleri* Dies., 5 specimens.

At Caesarea gephyreans were collected at three stations:

A. A rock platform reaching out into the sea as a small peninsula; the rock surface is usually submerged in 10—15 cm water. The animal community was composed mainly of Spongiae, various Polychaeta, Bryozoa, Crustacea (Amphipoda, *Alpheus* sp., *Pachygrapsus* sp.), Placophora, *Vermetus*, *Mytilus*, Synascidia, etc.

B. A small, shallow bay protected from the surf by several large rocks some 50 metres from the shore. On the bottom of the bay porous stones of various sizes are scattered. The animal community: Spongiae, Polychaeta (genera as above), Crustacea (*Alpheus*, *Clibanarius misanthropus*, *Porcellana platycheles*, *Xantho floridus*, *X. hydrophilus*, *Pachygrapsus* sp.), Patella, Monodonta, solitarian Ascidians and Synascidians.

C. A corner sheltered by the remnants of an ancient wall, with scattered stones and rocks of varying size. They are much less porous than those mentioned under site B. No information is given of the animal community.

* The samples taken in Caesarea were collected by Mrs. A. Ledermann—Klein, and all others by Mr. Ch. Lewinsohn.

** The name *Phascolosoma* has hitherto been used erroneously, referring to species with the mouth situated between the tentacles, whereas the generic name *Physcocoma* was used for those with the mouth placed ventrally to the tentacular crown. According to the law of priority it is this latter group, however, which should bear the name *Phascolosoma*. Fisher (1952, pp. 388–389) gives an account of the confusion between these generic names and points out that for the animals hitherto known as *Phasocolosoma* Lanchester's name *Golfingia* is available.

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Bull. Res. Counc. of Israel, Vol. 6B, 1957.

Phascolosoma granulatum Leuckart, 1828

Site A: 14.VII.1951, 2 spec., 0—0.2 m, in rock built by *Vermetus*.—1.VIII.1951, 1 spec., 0—0.5 m, in limestone with *Vermetus*. — 9.IX.1951, 2 spec., 0—0.2 m, in rock built by *Vermetus*. — 23.XI.1951, 5 spec., as above. — 29.XII.1951, 2 spec., 0—0.5 m, as above. — 15.III.1952, 16 spec., 0—0.5 m, in lime-sandstone. — 12.V.1952, 1 spec., 0—0.5 m, in lime-sandstone with *Vermetus*. — 13.V.1952, 19 spec., as above. — 10.IX.1952, 9 spec., 0—0.5 m, in sandy mud.

Site B: 31.V.1952, 7 spec., 0—0.5 m, in lime-sandstone wth *Vermetus*. — 15.VI.1952, 2 spec., as above. — 30.VIII.1952, 5 spec., as above.

Site C: 2.VIII.1951, 6 spec. (the largest of all), 0—0.5 m, in lime-sandstone. — 15.IX.1951, 4 spec., as above. — From NS/224, Appolonia, Mediterranean Sea, 2 spec., VIII.1951. — "Mediterranean" without specification, NS/222, 4 spec., no date. — NS/223, 4 spec., no date.

The numerous specimens are fairly well preserved. Only the 9 specimens from site A 10.IX.1952 were desiccated, and the 19 specimens from site A 13.V.1952 are all small, partly ruptured and imperfect. In only one single specimen was the introvert fully protruded. The specimens were all rather small, the size varying from 4.5 mm to 45 mm, by far the majority smaller than 20 mm. The correct measurements, as well as the ratio between trunk and introvert, cannot be given owing to the strong contraction and curved condition and the impossibility of straightening the animals. The coloration varies from dark brown to yellowish grey, with an irregular pattern of dark spots on the dorsal convex side of the trunk and darker transversal streaks on the dorsal side of the introvert (Figure 1). The ventral side is frequently lighter than the dorsal. This pattern on the trunk and introvert is common to *P. granulatum* and to the closely allied *P. nigrescens* Keferst. The skin is covered with papillae densely packed at the tip of

Figure 1
Phascolosoma granulatum Leuck. from St. NS 223.

the trunk and in a girdle round the base of the introvert. In these areas the papillae are dark, almost black, much higher than elsewhere and having the form of tri-

angular cones. At the ventral side of the trunk the papillae are rounded and lower, more scattered and covered with chitinous polygonal platelets. The majority of the specimens have the skin thick and opaque due to the strong contraction. Only a small number are more or less transparent, allowing the separated longitudinal muscle bands to show through.

As mentioned above, the proboscis was protruded in a single specimen. The tentacular crown was composed of 13 short, blunt, digitiform tentacles, forming a semicircle above the mouth with the open part turning dorsally. They were all bent away from the mouth and curved towards the interior of the semicircle, the bottom of which was an olive-green pad. The dorsal opening of the crown was closed by the heart-shaped nuchal organ. The length of the tentacles was characteristic. The midventral tentacle is shorter that those on the right and left; the next ones on both sides are of the same length as the mid-ventral one, the rest being progressively shorter.

Near the anterior end of the introvert and close to the tentacular crown begins the girdle of hooks, consisting of a number of complete rings of hooks, varying

Figure 2
Phascolosoma granulatum Leuck.
from St. NS 223.

highly in size and age. In the specimen with the protruded introvert 25 rings were counted; the number may rise to 60. The hooks are densely crowded, many hundreds per ring, strongly chitinized, dark brown, each measuring only about 0.05 mm in height and 0.06 mm in breadth at the base. They have a sharp and strongly curved apical tooth and a small, blunt accessory tooth in the middle of the concave edge. Inside the hook runs a narrow canal-like transparent streak following the convex edge. The structure of the hooks closely resembles the figure given by Selenka (1883, pl. X, fig. 147). About 4—6 transversal wrinkles are found at the base.

Several specimens were dissected (Figure 2). The longitudinal muscle layer is divided into separate bands, the number varying between 20 and 28, most frequently 24. The bands anastomosed only slightly; a little inside the anus and the apertures of the excretory sacs they fused into a continuous layer. Four almost equally strong retractors arise with 3—5 short, broad roots, the ventral ones from the 1st to the 5th, the dorsal ones a little in front of the ventral ones from the 6th to the 10th longitudinal muscle band. The two pairs of retractors soon unite to one strong muscle. A stout spindle muscle arises a little in front of the anus and is fixed to the posterior end of the trunk. Delicate fixing muscles attach the convolutions of the intestine to the body wall and the oesophagus to the retractors in the place where it separates from these; furthermore, a wing-like muscle sheet attaches the rectum, and fixing fibres fasten the anterior ends of the excretory organs to the body wall. The intestinal coil has about 8 spirals. A small rectal diverticle was found in three specimens, and in several specimens, but not in all, the polian vessel, running along the dorsal side of the oesophagus, had a number of very small, rounded tubules as shown in Figure 2. The segmental organs are moderately long and of a dark orange colour, their posterior half is slender, tube-like. The small nephrostome lies over the interval between the 2nd and 3rd muscle-bands. The nerve-cord is attached by its numerous lateral nerves. There are two dark eye-spots in the brain. In all the specimens examined the gonads were exceedingly thin and without sexual products.

Phascolosoma granulatum often uses the burrows made by rock-boring animals or natural crevices and holes, e.g. in coral blocks; it does not seem to bore itself. All the specimens in this collection were free, most probably they had been extracted from their holes by the collectors. According to information regarding the finding places, these latter consist of or are littered with porous stones in which the worms may have found shelter.

P. granulatum is closely related to *P. nigrescens* Keferst. 1865 (and to two American species, viz. *P. puntarenae* Gr. 1859 and *P. agassizii* Keferst. 1865). They resemble each other both in habits, structure of hooks and internal anatomy. *P. granulatum* is easily distinguished from *P. nigrescens* by the smaller number of hook-rings (in *P. nigrescens* 30—120), and the absence of an expansion on the concave side of the clear streak inside the hook; from *P. scolops* by the greater

number of hook-rings (in *P. scolops* 15—20). Both *P. nigrescens* and *P. scolops* are found in the Red Sea.

The present species is very common in the Mediterranean. Through the connection between this sea and the Red Sea it has passed into eastern areas. It has been reported from Zanzibar (Stephen and Robertson 1952). In the Atlantic Ocean it is known from the Cap Verde Islands, and it is especially common in the Lusitanian area.

The finds at the coast of Israel are not surprising; this coast may be considered a "station en route" to the eastern seas from the area of its main distribution, whence it has migrated both to the east and the west.

Aspidosiphon mülleri (Diesing), 1851

Site A: 13.V.1952, 2 spec., 0.05 m, in lime-sandstone, together with 19 spec. of *Phascolosoma granulatum.* — 10.IX.1952, 2 spec., about 0.5 m, in sandy mud.
Site C: 15.IX.1951, 1 spec., 0—0.5 m, in lime-sandstone, together with 4 spec. of *P. granulatum.*

The 5 specimens are rather small and juvenile, all of a light colour. In the largest one with protruded introvert this measures 12 mm, the trunk 13 mm. The anal shield is brown, constructed of platelets radially arranged and not distinctly set off from the neighbouring parts. The caudal shield is symmetrically arranged round the tip of the trunk and neatly radially furrowed.

In the specimen with perfectly protruded proboscis the hooks were arranged as follows: an area with about 45 closed rings was followed by an area with scattered hooks; then followed five closed rings, and finally a girdle with scattered hooks. The aspect of the hooks is different. In the closed rings they have a long, slender manubrium, a broad neck, and a sharply curved rostrum ending in a long, pointed fang, below which is an accessory tooth only slightly shorter than the main fang. In the posterior rings this accessory tooth diminishes. In the area with scattered hooks the shape of the hooks alters. The manubrium is shorter and broader, and the accessory tooth is always much smaller than the main tooth, in many hooks it is even completely absent. Between the scattered hooks there are rather high, conical papillae, whereas those between the rings are elliptic and flat.

The tentacular crown consists of 8 very short, blunt tentacles dorsally to the mouth; they are broad and with an indistinct longitudinal furrow on their exterior side. They are arranged in a semicircle which is closed by a low pad; the rim of the mouth is undulating.

The longitudinal muscles form a continuous layer. There are two slender retractors arising close to the posterior end and a spindle muscle fastens close to the posterior end of the trunk. The intestine forms an irregular coil; the ascending part of it is amost straight, partaking in the spiral at the bottom of the trunk only, the rectum is long and straight, fastened at the anus by means of delicate wing muscles.

A rectal diverticle could not be found. The excretory organs are very long, reaching almost to the posterior end; the external aperture is on the same level as the anus. Sexual organs not developed.

A. mülleri is nearly always found in cavities in rocks and stones of more or less porous nature, or in corals and often in empty gastropod shells — just as is the case with *Phascolosoma granulatum*. In the present material one specimen is still surrounded by a fragment of the shell of a *Vermetus*. Only by crushing their residence is it possible to secure the specimens undamaged, otherwise they cannot be removed from their galleries. The worms are not able to make the cavities themselves; they always make use of existing burrows.

A. mülleri is widely distributed and common in the Mediterranean. From there it immigrated to the Red Sea and further eastwards, since it is reported from Aden, the Malayan archipelago and Japan; westwards it has spread to the Atlantic Ocean; it is common in the Lusitanian area; Southern (1912, p. 31) says that it is the commonest gephyrean in deep water off the west coast of Ireland. Northwards it even enters the Arctic. Southwards it can be traced via the Azores, Madeira and the Cap Verde Islands to the African west coast where it is recorded from Accra (the Gold Coast), Dahomey, Guinea and French Congo.

Aspidosiphon elegans (Chamisso and Eysenhardt), 1821

Site A: 15.III.1952, 1 spec. 0.05 m, in lime-sandstone. — NS 220, the Mediterranean, without further specification, 1 spec.

The only two specimens are small and fairly badly preserved. The specimen from NS 220 measures 17 mm without proboscis, which is totally withdrawn. The caudal shield is pale, not yet chitinized, with the platelets in two rings round the outmost tip of the trunk, which protrudes centrically like a small cone. Most probably the specimen is juvenile. Full-grown specimens may reach a size of 80 mm or more.

The specimen from Caesarea is still smaller, only 9 mm, also with perfectly withdrawn introvert. The skin is transparent and very thin, set with elliptical flat, glandular bodies irregularly scattered all over the body and covered with small plates and with a minute central pore. Also here the caudal shield is very indistinct, colourless, hardly indicated round the blunt posterior end. The anal shield is granulous, not radially furrowed. The opening of the invaginated introvert is a narrow fissure at its ventral side.

This specimen was dissected (Figure 3). The longitudinal muscle layer is continuous. There are two retractors with broad membranaceous roots, arising two millimetres in front of the posterior end; they very soon fuse into one. Throughout their length and especially distinct in the coalesced part the retractors are very finely annulated by numerous closed rings of a light brown colour. The intestinal coil consists of 12 spirals fastened posteriorly by a spindle muscle. No other fixing

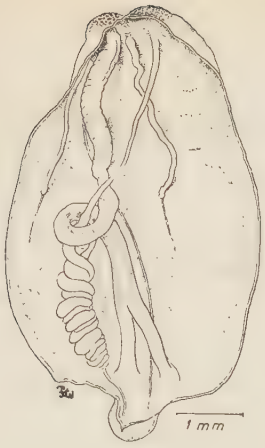

Figure 3
Aspidosiphon elegans (Cham. & Eysenh.) from St. NS 220.

muscles were found. The rectum is fastened to the body wall by means of a delicate wing muscle. No rectal diverticle. The anus at the dorsal edge of the anal shield is hardly visible as a narrow transversal fissure. The part of the intestine which accompanies the retractor forms a wide, violet-brownish canal; the colour disappears where the oesophagus separates from the muscle. As shown in the figure there is close behind the eye spots (1 to the left and 2 (!) to the right) a short, globular oesophageal blind sac. The segmental organs are long, slender tubes, more than half the length of the trunk; in their whole length they are fastened to the body wall be a mesentery which arises far behind their posterior tips. Their internal opening is a funnel surrounded by a cordiform collar; their external aperture is on the same level as the anus and close to the ventral nerve-cord. The sexual organs appeared as two slightly developed bands at the roots of the retractors. The specimen was undoubtedly immature.

It was not considered advisable to open the introvert and therefore the number of hook-rings and the structure of the hooks cannot be stated.

The species is widely distributed in eastern tropical areas: Palau, Yap, Formosa, Philippine Islands, Malay Peninsula, Funafuti and Loyalty Islands; East Africa, and from here it has immigrated through the Red Sea where it is reported from Koseir, into the Mediterranean, from where it has not previously been recorded.

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SPONGIAIRES DES COTES D'ISRAEL

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ABSTRACT

Thirty species are identfied of which only one is new: *Axinella minuta* nov. sp. All the species are Mediterranean, none are immigrants from the Suez Canal.

Dans son petit guide rapide pour la connaissance des Eponges de la Méditerranée, Topsent (1945) résume surtout les résultats des recherches consacrées aux Spongiaires de l'Adriatique et du Bassin occidental méditerranéen (côtes de France, d'Italie et d'Algérie). Il achève à cette occasion son difficile travail de révision des diagnoses si succintes de Schmidt. Il note enfin le très petit nombre de publications consacrées aux Eponges du Bassin oriental qui n'ont été recherchées avec soin qu'en deux points fort éloignés: le Golfe de Gabès et la côte d'Alexandrie.

C'est pourquoi la collection d'M. E. Gottlieb de la Station de Recherches de la Pêche Maritime, Haifa présente un intérêt tout particulier car elle nous permet de connaître la faune de l'extrémité orientale de la Méditerranée et d'apprécier ainsi les observations de Burton sur les éponges d'Alexandrie et du Canal de Suez.

En dépit du grand nombre d'échantillons récoltés par M. E. Gottlieb, il est manifeste que les éponges des fonds littoraux de la côte d'Israel sont relativement peu nombreuses; il est certain que de nouvelles prospections augmenteront la liste des espèces, mais des dragages équivalents effectués dans le Bassin occidental et même dans le Golfe de Gabès auraient apporté un choix d'espèces plus étendu.

La plupart des espèces sont représentées dans la collection par plusieurs specimens, dont la taille est toujours modeste, au dessous de la moyenne des échantillons occidentaux, ce qui correspond aux remarques de Burton à propos des éponges d'Alexandrie. Les dominantes sont: *Chondrosia reniformis* (Nardo), *Cliona viridis* (O.S.), *Spirastrella cunctatrix* Schmidt, *Mycale massa* (Schmidt), et *Agelas oroïdes* (Schmidt). Les Axinellides sont abondamment représentées, plus spécialement par *A. polypoïdes*, *A. cannabina* (Esper), et *A. minuta* n. sp.

Autant qu'il soit actuellement possible de l'affirmer, la côte d'Israël ne révèle pas d'espèces d'origine indopacifique. Je voudrais signaler à ce propos que la *Didiscus placospongioïdes* Dendy, découverte par Burton au large d'Alexandrie, ne peut

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être tenue avec certitude pour immigrante à travers le Canal de Suez, car l'espèce vit également sur la côte de la Guadeloupe et fait donc partie des espéces à distribution circumtropicale.

Les éponges recueillies par E. Gottlieb sont les suivantes:

		Stations
Tetractinomorphes		
Homosclerophorides:	*Oscarella lobularis* (O.S.)	135
	Corticium candelabrum O.S.	145
Tetractinellides:	*Geodia conchilega* O.S.	132, 135, 298
	Penares helleri (O.S.)	98
	Chondrosia reniformis (Nardo)	72, 78, 84, 132, 195, 231, 257, 298
Clavaxinellides:	*Tethya aurantium* Pallas	98
	Aaptos aaptos (O.S.)	133, 195
	Cliona schmidti Ridley	96
	Cliona viridis (O.S.)	71, 73, 96, 98, 121, 176, 183, 195, 226, 258
	Spirastrella cunctatrix O.S.	98, 100, 135, 257, 272, 273, 298
	Axinella verrucosa (Esper)	
	Axinella polypoïdes O.S.	98, 183, 191, 272
	Axinella cannabina (Esper)	135, 226
	Axinella minuta n. sp.	200, 202, 263, 289
	Raspailia viminalis O.S.	78
	Raspaciona aculeata (Johnston)	
	Spongosorites genitrix (O.S.)	132, 185
Ceractinomorphes		
Halichondrides	*Halichondria* sp.	678
Poecilosclérides	*Mycale massa* (O.S.)	98, 104, 120, 183, 195, 218, 231
	Myxilla rosacea (Lieberkühn)	98
	Myxilla (?) *prouhoi* (Topsent)	169
	Agelas oroïdes (O.S.)	96, 98, 104, 132, 133, 135
Haplosclérides	*Gellius fibulatus* (O.S.)	273
	Petrosia dura Nardo	135
	Adocia simulans (Johnston)	
	Haliclona cratera (O.S.)	195, 297
	Haliclona spp.	170, 257, 297, 678
Dendrocératides	*Hexadella racovitzai* Topsent	96
Dictyocératides	*Cacospongia cavernosa* O.S.	98, 257
	Hircinia variabilis O.S.	298, 678
	Spongia officinalis Linné	107

A l'exception des stations 191 (43 m), 236 (53 m), et 678 (90 m), toutes les autres sont à des profondeurs qui s'échelonnent entre 10 et 30 mètres environ. Mais la profondeur ne joue pas en elle même de rôle déterminant sur la distribution des espèces dans ces faibles limites. L'étude des associations animales sera plus riche d'enseignements. Il ne me parait pas nécessaire de redécrire une nouvelle fois en

détail les espèces récoltées communes dans toute la Méditerranée et je me bornerai à indiquer la dimension des spicules de certaines d'entre elles pour une étude éventuelle de leur variabilité et à discuter quelques points taxonomiques litigieux.

Geodia conchilega O.S. (Figure 1)

Eponge massive, à écorce lisse et rigide; aspect typique.

SPICULES: *Oxes* fusiformes réguliers : 2300 μ.
Ortho et *dichotriaenes* à clades de 170 μ ou 100+70 μ.
Anatriaenes à rhabde fin et clades de 35—40 μ; ouverture du cladome : 50 μ.
Sterrasters dermiques, ellipsoïdes ou sphériques de dimensions relativement faibles: 75/75 μ ou 75/100 μ.
Tylasters dermiques à boutons distaux parfaits : 6—7 μ.
Oxyasters choanosomiques: 22—24 μ.
Sphaeroxyasters subcorticaux à actines épineuses.

REMARQUES: Les specimens de la côte d'Israël se rapprochent nettement de la *Geodia conchilega* occidentale caractérisée par la grande taille et la forme elliptique de ses sterrasters. Les dimensions des spicules restent sensiblement plus faibles. Le mélange d'orhotriaenes et de dichotriaenes est fréquent dans cette espèce. Les microsclères ectosomiques sont ici des tylasters bien conformés et non des chiasters comme dans les autres specimens observés.

Figure 1
Geodia conchilega O.S.

Penares helleri (O.S.) (Figure 2)

Stelleta helleri Schmidt 1864

Eponge massive, assez dure.

SPICULES: *Oxes* principaux: 650 à 1250 μ/35 μ.
Dichotriaenes à protoclades assez longs: 110—140 μ et deuteroclades: 120—200 μ; rhabde: 225 à 400 μ.
Microxes fusiformes de toutes tailles entre 35 et 240 μ.
Oxyasters choanosomiques, très abondants: 30—40 μ.

Spirastrella cunctatrix O. Schmidt (Figure 3)

Nombreux specimens blanc rosé, revêtant des supports variés.

SPICULES: *Tylostyles*, tête arrondie, quelquefois polytylotes, à pointe effilée; peu nombreux. 550 μ/8—9 μ. Tête longue de 20—25 μ et large de 12—13 μ.
Spirasters assez trapus, souvent proches de l'état amphiaster, mais les plus petits sont des spirasters très réguliers: jusqu'à 40 μ de long.

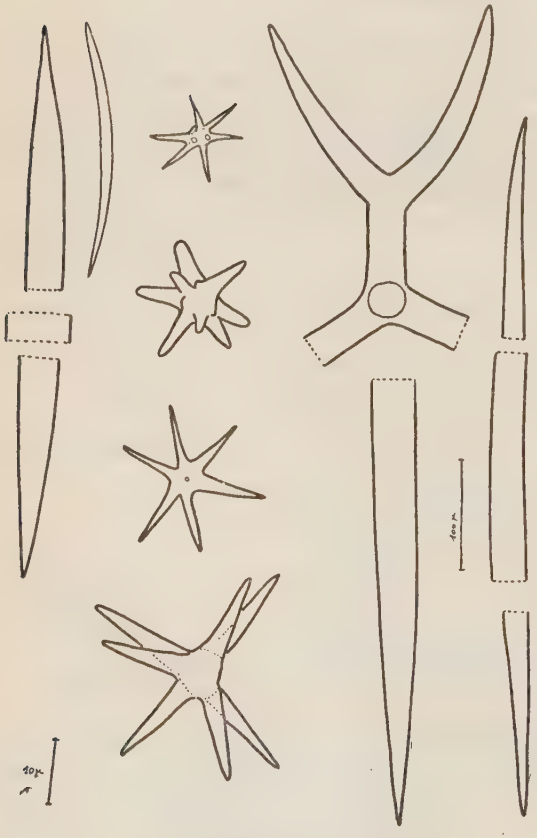

Figure 2
Penares helleri (O.S.)

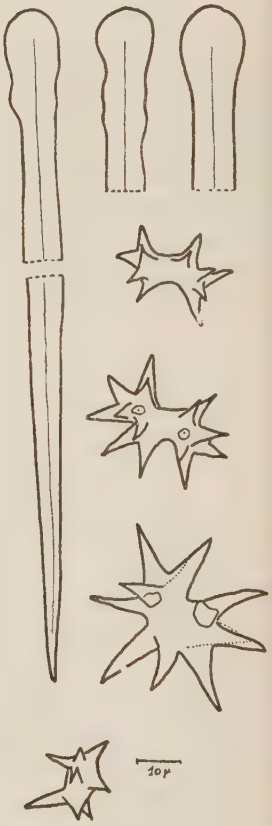

Figure 3
Spirastrella cunctatrix O.S.

Axinella **minuta** n. sp. (Figure 4)

DESCRIPTION: La collection de M. E. Gottlieb renferme 4 specimens de cette très petite *Axinella* dont l'aspect externe concorde à peu près avec la description qu'a donné Babic (1922) de son *Axinella pumila* adriatique. D'une sorte de coussinet basal, encroutant le support, coquille ou caillou, s'élèvent quelques prolongements perpendiculaires à la base, légèrement ramifiés et assez hispides, qui mesurent en moyenne 2 cm de haut et 2 mm de large à la base, le sommet des rameaux n'excédant pas 0.5 mm de diamètre. Le coussinet est soutenu par une grande quantité de styles plantés par leur tête et de taille inégale, assez courts cependant. L'axe des rameaux principaux est très dense, recouvert par un réseau de styles emboités dans de la spongine. Ce réseau subsiste seul dans les prolongements latéraux secondaires des rameaux.

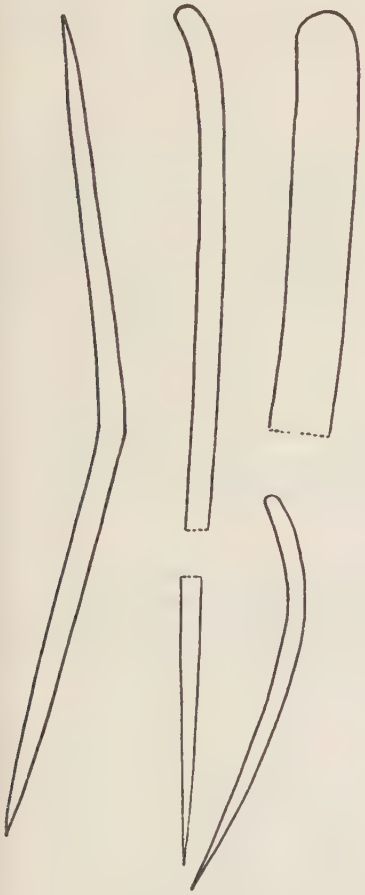

Figure 4
Axinella minuta n. sp.

Figure 5
Spongosorites genitrix (O.S.)

SPICULES: *Styles* principaux, longs, généralement droits, à pointe régulièrement effilée: 1200 μ.
Styles, courbés à la base, plus légèrement que les rhabdostyles: 120—300 μ.
Oxes symétriques à nette courbure médiane, de même taille que les styles précédents.

Par leur aspect, les spicules d'*A. minuta* n. sp. s'apparentent à ceux d'*A. pumila* Babic, dont les dimensions sont nettement supérieures. Il n'est pas impossible qu'on découvre en Méditerranée orientale des specimens à spiculation intermédiaire, auquel cas les deux espèces viendraient en synonymie.

Spongosorites genitrix (O. Schmidt) (Figure 5)

Amorphina genitrix Schmidt 1870
Halichondria genitrix Luendbeck
Topsentia genitrix Topsent 1920

Petite éponge d'un noir brillant, dans les anfractuosités du substrat coralligène

SPICULES: *Oxes* 1: 400—750 μ/11—15 μ, à pointes très souvent altérées et difformités nombreuses.
Oxes 2: 350 μ/8—10 μ.
Oxes 3: à partir de 100 μ/1.5—2 μ.

Cette espèce répandue dans la Méditerranée et caractérisée par ses trois types d'oxes possède fréquemment des oxes de grande taille, monstrueux. Elle se distingue de *S. pachastrelloides* (Topsent) par la taille moindre de ses spicules. A cet égard le specimen de la Calle (Topsent 1901), dont les spicules mesurent 1 mm, est intermédiaire entre les deux espèces, mais je pense qu'il s'agit plutôt d'un échantillon de *S. genitrix*, car la distribution bathymétrique de *S. genitrix* est loin d'atteindre celle de *S. pachastrelloides*.

Successivement placée dans les genres *Amorphina*, *Halichondria* et *Topsentia*, cette espèce doit se ranger dans le genre *Spongosorites*, dont j'ai déjà noté les ressemblances avec le genre *Topsentia* (1955). Leur ancienne distinction basée sur la présence ou l'absence d'une membrane dermique est difficile et le specimen d'Israël n'en présente nulle trace, bien que parfaitement intact.

En ce qui concerne la dénomination spécifique: *genitrix* est une espèce du grand nord atlantique et rien ne permet encore d'affirmer que les specimens méditerranéens sont conspecifiques. Il est probable que ce nom specifique de *genitrix* recouvre actuellement deux si ce n'est trois espèces d'aspect et de couleur différents.

Raspaciona aculeata (Johnston) (Figure 6)

Halichondria aculeata Johnston 1842
Dictyocylindrus aculeatus Bowerbank 1866—74
Raspailia aculeata Hanitsch 1894

Un specimen orangé encroutant de cette curieuse espèce caractérisée par la formation d'ébauches de colonnettes spiculeuses, très hispides à partir d'une croute basale assez mince, mais étendue sur le substrat.

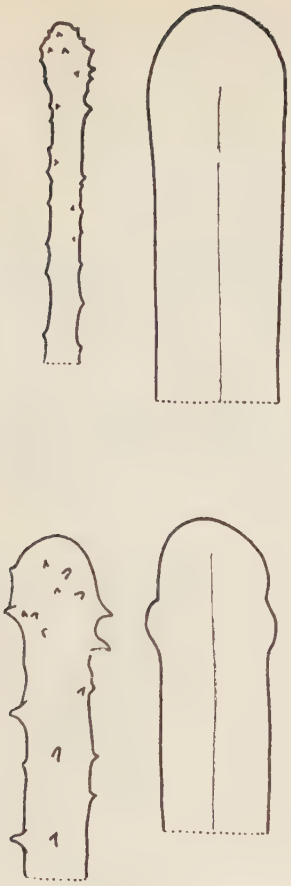

Figure 6
Raspaciona aculeata (Johnston)

Figure 7
Mycale massa (O.S.)

SPICULES: *Tylostyles* principaux, parfois subtylostyles, forts: 800 μ à 3 mm/15—25 μ.
Acanthostyles accessoires, à épines peu nombreuses et courbés dans le tiers proximal: 150—325 μ/5—10 μ.

Styles ou styloxes rhaphidiformes, rares: 400 μ de long.

Halichondria sp.

Petit specimen massif, jaunatre pâle, amorphe, de 2 cm de haut environ.

SPICULES: *Oxes* assez fins et élancés, entrecroisés dans toute l'éponge. La taille normale des spicules est 300—350 μ/4 μ mais on en rencontre de plus petits, jusqu'à 125 μ.

Mycale massa (O. Schmidt) (Figure 7)

Esperia massa Schmidt 1862

Eponge abondante, massive, à ectosome détachable, assez parcheminé.

SPICULES: *Styles* à tête assez mince et presque pointue, avec diamètre maximum au centre droits ou courbés: 400—550 μ/9—12 μ.
Anisochèles: 50—62 μ.
Sigmas: 45 μ/3 μ.
Rhaphides abondants: 45 μ.

Myxilla (?) *prouhoi* (Topsent) (Figure 8)

Damiria prouhoi Topsent 1892
Pachychalina de bueni F. Hernandez 1921
Myxilla anhelans (O.S.) Babic 1922

Eponge molle, massive plus ou moins ramifiée, irrégulière, à surface lisse et réseau squelettique en profondeur.

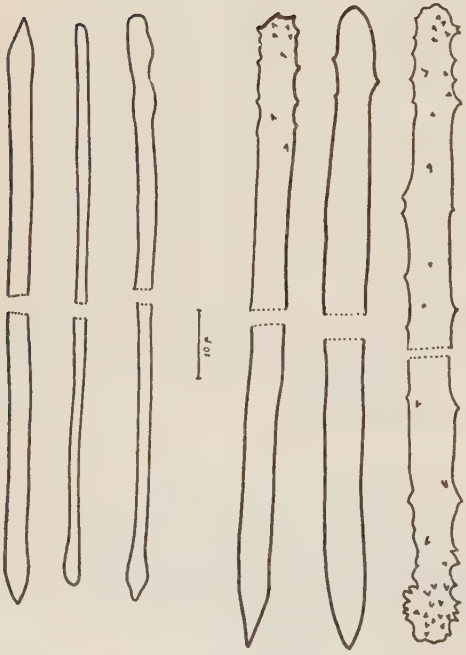

Figure 8
Myxilla prouhoi (Topsent)

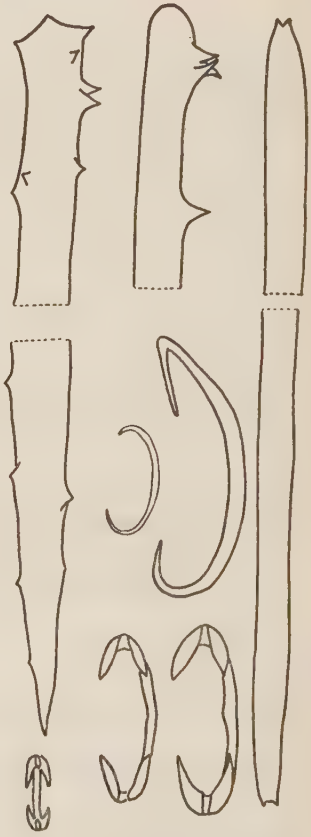

Figure 9
Myxilla rosacea (Lieberk.)

SPICULES: *Acanthostyles* principaux, généralement peu courbés et même droits, à structure très variable, depuis les spicules à tête et pointe épineuses jusqu'aux spicules presque lisses. L'extrémité distale est normalement obtuse ou tronquée et la pointe aiguisée est exceptionelle: 150—210 μ/10—13 μ.

Subtylotes dermiques, assez grèles, faiblement courbés, dont les extrémités souvent inégales sont régulièrement arrondies ou renflées en fer de lance. Quelques uns sont polytylotes près de leurs extrémités: 180—240 μ/2—5 μ.

Ce specimen est totalement dépourvu d'isancres et c'est sur la foi des observations consignées par Topsent (1925) de la variabilité de la spiculation que je le classerai dans le genre *Myxilla*. Le diamètre des spicules est d'autres part relativement fort.

Gellius fibulatus (O. Schmidt) (Figure 11)

Reniera fibulata O.S. 1862
Gelliodes fibulata Ridley 1887

Figure 10
Agelas oroïdes (O.S.)

Figure 11
Gellius fibulatus (O.S.)

Petit fragment d'une éponge d'1.5 cm de diamètre à la base, dressée tubulaire, à cavité longitudinale irrégulière de 3 mm de diamètre. Surface très finement veloutées Squelette assez régulier à mailles triangulaires paucispiculées, avec quelques fibres longitudinales éparses.

SPICULES: *Oxes* fusiformes peu courbés et ventrus: 150—185 μ/7—15 μ.
Sigmas en C à allure brisée et largement ouverts: 15—20 μ.

C'est avec beaucoup d'hésitation que je rapporte ce specimen à l'espèce *fibulatus* et me base surtout sur l'opinion de Topsent, suivant laquelle l'espèce passe suivant les localités de l'état *Gellius* à celui de *Gelliodes* suivant sa teneur en spongine.

Je pense qu'en réalité, le fragment de la côte d'Israël doit appartenir à un véritable *Gellius* caractérisé par la forme de ses sigmas, très grêles, brisés et ouverts. Seule une étude ultérieure des *Gellius* méditerranéens permettra de résoudre cette question.

Haliclona cratera (O. Schmidt) (Figure 12)

Reniera cratera O.S. 1862

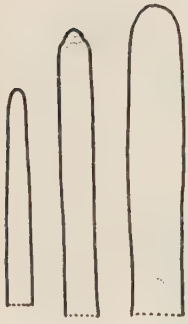

Figure 12
Haliclona cratera (O.S.)

Figure 13
Petrosia dura (Nardo)

Eponge en cheminée tubulaire de 8 mm de diamètre, avec un oscule terminal et un canal axial de 2 mm de diamètre. Le squelette est composé d'un réseau isodictyal assez confus de *strongyles* de taille variable entre 210 et 330 μ/7—15 μ. Ces spicules sont légèrement courbés et leurs extrémités subégales sont souvent marquées par un léger rétrécissement à allure de mucron obtus. Le canal axial s'arrête avant le bourrelet terminal. Le diamètre moyen du spicule varie en fonction inverse de la longueur ce qui semble indiquer que la quantité générale de silice est constante pour chaque spicule.

La comparaison des récoltes de Spongiaires de côtes d'Israël et d'Alexandrie révèle une certaine similitude de l'ensemble de la faune et de ses dominantes. Mais, des quatre catégories d'éponges établies par Burton, les catégories 3 et 4 c'est à dire, les espèces d'origine indo-pacifiques et celles jusqu'alors seulement connus de l'Atlantique nord, ne sont pas représentées sur le littoral d'Israël.

Sur les 23 espèces des côtes nord de la Méditerranée, signalées au large d'Alexandrie, 7 seulement vivent sur la côte d'Israël. Enfin, 9 des 14 espèces généralement répandues en Méditerranée sont représentées dans la collection de M. Gottlieb.

Sur les 29 espèces identifiées de cette collection, 13 sont inconnues des côtes d'Egypte, dont 9 sont déjà signalées sur les versants N. et S. de la Méditerranée.

En résumé, sur les 29 espèces identifiées:

18 ont déjà été signalées sur les côtes N. et S. de la Méditerranée.

10 ont été signalées sur les côtes N.

1 est nouvelle.

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CONTRIBUTION A LA FAUNE DES ANNELIDES POLYCHETES DES COTES D'ISRAEL. II.

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ABSTRACT

A short note on Polychaeta of Haifa, and a new description of *Rhodine loveni* Mgr. var. *gracilior* Tb., genus and species new for the Mediterranean.

Dans une courte note précédente (1955) nous avons déjà étudié une petite collection de Polychètes de Césaréa et d'Athlit. Dans la présente note nous étudions les Polychètes de la baie d'Haïfa dont M. E. Gottlieb nous a aimablement confié la détermination.

Cette petite collection ne représente qu'une faible partie du matériel recueilli par la "Sea Fisheries Research Station" dans la baie d'Haïfa sur des fonds de 10 à 50 brasses. (90 metres).

Elle comprend néanmoins 59 espèces appartenant à 20 familles et toutes connues depuis longtemps dans la Méditerranée, à l'exception cependant de la *Rhodine loveni* Malmgren, var. *gracilior* Tauber, genre et espèce qu'on n'y avait encore jamais signalés et dont la présence inattendue est fort intéressante au point de vue de la distribution géographique. Nous lui consacrerons donc une étude assez détaillée.

Une particularité de cette petite collection est la petitesse relative de la plupart des espèces dont beaucoup sont des jeunes mesurant à peine quelques millimètres.

Les familles les mieux représentées sont: les Euniciens (15 espèces) et les Syllidiens (8 espèces). Les stations qui ont fourni le plus grand nombre d'espèces sont: N° 110, avec 14 espèces; N° 135 avec 17 espèces et N° 268, avec 15 espèces.

APHRODITIDAE

Hermione hystrix Savigny. N° 236.
Harmothoë spinifera Ehlers. N° 169, 291.
Harmothoë sp. N° 268 (Débris).
(?) *Allmaniella setubalensis* McIntosh. N° 273; Les soies ventrales sont de deux sortes, mais les cirres et les élytres manquant la détermination reste douteuse.

CHRYSOPETALIDAE

Chrysopetalum debile Grube. N° 241.

Received May 16, 1956.

AMPHINOMIDAE

Hermodice carunculata (Pallas). N° 135, 169, 289.

NEPHTHYDIDAE

(?) *Nephthys hombergi* Aud. et Mn. Edw. N° 110, 268. Fragments.

SYLLIDAE

Syllis spongicola Grube. N° 135, 241, 297.
Syllis gracilis Grube. N° 135, 272.
Syllis khronii Ehlers. N° 297.
Syllis armillaris Malmgren. N° 128, 135, 272.
Syllis variegata Grube. N° 135.
Syllis amica Quatrefages. N° 135.
Syllis (*Ehlersia*) *cornuta* Grube. N° 110, 135, 272.
Trypanosyllis zebra Grube. N° 135, 169, 268.

PHYLLODOCIDAE

Kefersteinia cirrata (Keferstein). N° 128.
Eulalia punctifera Grube. N° 135, 241.

NEREIDAE

Nereis rava Ehlers. N° 128, 241.
Nereis (*Ceratonereis*) *costae* Grube. N° 268.
Platynereis dumerilii Aud. et Edw. N° 169, 268, 291. Toutes sont atoques.

EUNICIDAE

Eunice pennata O. F. Mueller. N° 291, 297.
Eunice vittata Delle Chiaje. N° 128, 135, 169, 180, 241, 258, 268, 273, 280. Très nombreux spécimens, la plupart de très petite taille.
Eunice torquata Quatrefages. N° 135, 169, 258, 268, 273, 280.
Marphysa fallax Marion et Bobretzky. N° 135, 155, 169, 273.
Lysidice ninetta Aud. et Edw. N° 135, 169, 241, 273, 291.
Nematonereis unicornis (Grube). N° 241.
Drilonereis filum Claparède. N° 110.
Hyalinoecia tubicola (O. F. Mueller). N° 254.
Lumbriconereis latreillii Aud.-Edw. N° 128, 291.
Lumbriconereis impatiens Claparède. N° 135, 241, 268.
Lumbriconereis coccinea Renieri. N° 135.
Lumbriconereis gracilis Ehlers. N° 128, 135, 258, 268, 291.
Arabella iricolor (Montagu). N° 110.
Staurocephalus rubrovittatus Grube. N° 169.
Staurocephalus kefersteini McIntosh. N° 135. Un, remarquablement petit.

GLYCERIDAE

Glycera rouxii Aud.-Edw. N° 110.
Glycera unicornis Savigny. N° 278.
Goniada norvegica Oersted. N° 241.

CIRRATULIDAE

Cirratulus chrysoderma Claparède. N° 110, 268.

SPIONDAE

Aonides oxycephala (Sars). N° 110, 280.

DISOMIDAE

Poecilochaetus serpens Allen. N° 110. Stade larvaire.

CHLORAEMIDAE

Stylarioïdes eruca Claparède. N° 128.

CAPITELLIDAE

Dasybranchus caducus Grube. N° 110.
Notomastus sp. N° 268.

MALDANIDAE

Clymene (*Euclymene*) *palermitana* Grube. N° 128, 280.
Clymene sp.

Rhodine loveni Malmgren, var. *gracilior* Tauber.

Rhodine loveni Malmgren, 1865, p. 189; 1867, p. 209, pl. XI, fig. 61.
Rhodeni loveni Tauber, 1879, p. 123.
Rhodine loveni Arwidsson, 1906, p. 61, pl. II, figs. 39—52; pl. VII, figs. 235—236; pl. XI, figs. 346—347.
Rhodine loveni Ehlers, 1908, p. 134.
Rhodine loveni Mesnil et Fauvel, 1939, p. 13, fig. 8.
Rhodine gracilior Arwidsson, 1906, p. 74, pl. II, figs. 53—58, pl. VII, figs. 237—241, pl. VIII, figs. 242—243.
Rhodine gracilior Nolte, 1913, p. 19, pl. I, figs. 1—25, pl. II, fig. 20.
Rhodine intermedia Arwidsson, 1911, p. 11, pl. I, figs. 5—11, pl. II, figs. 39—41.
Rhodine intermedia Monro, 1930, p. 170, fig. 70.
Rhodine intermedia Fauvel, 1953, p. 13.
Rhodine attenuata Verrill, 1873, p. 610.
Rhodine sima Ehlers, 1887, p. 189, pl. 47, figs. 6—10.
Rhodine antarctica Gravier, 1907, p. 39, pl. IV, figs. 33—37.

Haïfa N° 268. Baie d'Haïfa, 23 brasses. Sable vaseux.

Cette espèce n'est représentée que par un seul individu réduit à deux fragments, un antérieur, long de 25 mm, large de 1.5 mm, comprenant la tête et 11 segments sétigères et un postérieur long de 20 mm sur 1 mm de large, avec 11 segments sétigères, auquel manquent les derniers segments précédant le pygidium.

Le fragment antérieur est pourvu d'une tête régénérée, relativement petite et fragile, en partie renfermée à l'intérieur d'un entonnoir évasé formé par la collerette d'un premier segment sétigère presque deux fois plus long que le suivant (fig. 1,*a*).

Ce premier segment sétigère, qui correspond en réalité au deuxième d'un individu intact, porte, en avant, de chaque côté, un petit faisceau de soies capillaires. Le second segment est également pourvu d'une collerette circulaire à bord mince, uni, sans échancrure et ne porte aussi que des soies capillaires, ainsi que le troisième. Les segments 4, 5, 6, 7, très courts, sont divisés en deux parties dont l'antérieure porte un bourrelet glandulaire transversal qui se continue à la face dorsale par deux bourrelets longitudinaux latéraux. Ces bourrelets glandulaires se colorent en vert-bleu lorsqu'on les traite par le vert d'iode, suivant la méthode d'Arwidsson.

Les segments 8, 9, 10, 11 sont beaucoup plus longs et, avec le vert d'iode, ne montrent qu'un mince anneau bleu antérieur et un postérieur plus étroit. La tête

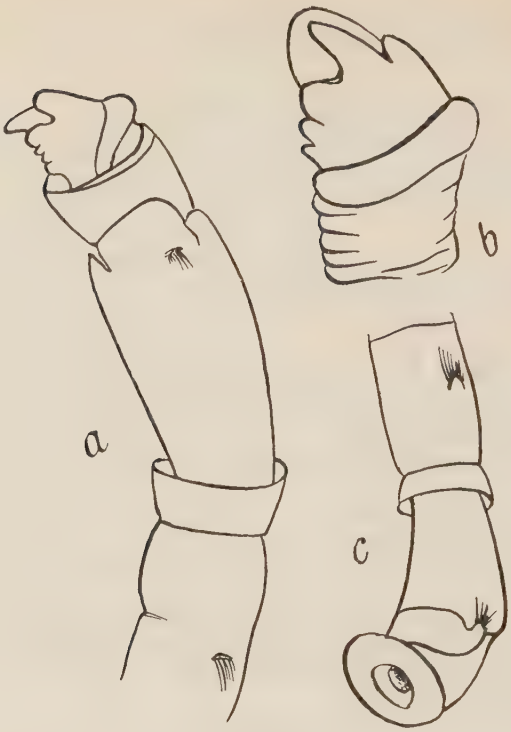

Figure 1

Rhodine loveni: (a) région antérieure × 10, (b) tête × 15, (c) région postérieure × 10, (Fr. Rullier del.)

est en forme de carène convexe, dépourvue de limbe, à prostomium conique, sans yeux et à organes nucaux arqués et encore peu marqués. On distingue en arrière un bourrelet transversal. Cette tête est portée sur un court pédoncule vaguement ridé inséré au fond de la collerette et encore pourvu de soies et qui est un rudiment du premier sétigère en cours de régénération et dont le bourrelet transversal représente la partie antérieure.

La petite tête, encore très fragile (fig. 1,*b*), s'est détachée au cours des manipulations. Les uncini, qui manquent aux trois segments antérieurs du fragment, sont, dans la région thoracique, disposés sur deux rangées parallèles opposées, engrenantes. Cette disposition qui rappelle celle des uncini thoraciques des Térébelliens est tout-à-fait exceptionelle chez les Maldaniens et ne s'y rencontre que dans le genre *Rhodine*. Ces uncini en crochet à long manubrium ressemblent singulièrement à ceux de certaines *Pista*. Le fragment postérieur comprend, d'avant en arrière, trois longs segments ne prenant le vert d'iode que sur un mince anneau, à la hauteur des tores uncinigères. Les suivants sont courts et se colorent fortement. Le bord postérieur du dixième forme une collerette ouverte vers l'arrière et le onzième se termine également par une collerette circulaire sans échancrure au fond de la-

quelle on distingue encore la trace de l'insertion du segment suivant qui manque et que l'on pourrait prendre pour un anus au fond d'une ventouse pygidiale, erreur dont fut victime Gravier en décrivant une *Rhodine antarctica* qu'il reconnut ensuite être une *Rhodine intermedia* Arwidsson (Gravier 1911) (fig. 1,*c*).

Au premier abord, l'aspect de la *Rhodine* d'Haïfa est vraiment déconcertant car dans ce genre la tête est portée à l'extrémité du premier sétigère qui est très long et dont un simple renflement dorsal la sépare à peine. Ce segment porte antérieurement de fines soies capillaires et vient s'insérer en arrière au fond de la collerette du deuxième sétigère.

Ehlers, cependant (1887, p. 189, pl. 47, figs. 6—10), a décrit une *Rhodine sima*, du golfe du Mexique, qui ressemble étrangement au spécimen d'Haïfa et qui ne diffère d'une *Rhodine loveni* que par sa tête incluse dans la première collerette et qui en est également un individu à tête régénérée. Les *Rhodine* sont très fragiles et Arwidsson nous apprend que les régénérations antérieures et postérieures sont très fréquentes et que les individus entiers sont même rares.

Dans les deux cas ci-dessus, la régénération est encore incomplète, la tête seule est assez bien formée et le premier sétigère n'est représenté que par son renflement antérieur et un petit pédoncule encore dépourvu de soies.

Le genre *Rhodine*, outre d'autres caractères génériques, est surtout caractérisé, I°, par l'absence de soies ventrales (uncini ou crochets) aux quatre premiers sétigères; 2°, par la disposition des uncini, dans la région antérieure, sur deux rangées parallèles opposées (caractère unique dans la famille des Maldanidae); 3°, par la présence de plusieurs collerettes ouvertes vers l'avant et d'autres collerettes, aux segments postérieurs, ouvertes vers l'arrière.

Arwidsson a même considéré ces caractères comme assez importants pour justifier la création d'une sous-famille distincte, celle des Rhodininae, qui ne comprend encore que le seul genre *Rhodine*.

L'espèce la plus anciennement connue est la *Rhodine loveni* Malmgren (1865) dont Tauber (1879, p. 122) a distingué trois variétés: (a) *robustior*, (b) *gracilior*, et (c) *breviceps*. Verrill (1873, p. 610) décrivit ensuite une *Rhodine attenuata* des côtes de New Jersey, puis Ehlers (1887, p. 189) décrivit une *Rhodine sima* du golfe du Mexique. Arwidsson, en 1907, dans un important travail sur les Maldanidae scandinaves et arctiques, érigea en espèce distincte: *Rhodine gracilior*, une des variétés de Tauber de la *Rhodine loveni*, et, un peu plus tard (1911), décrivit sous le nom de *Rhodine intermedia* une espèce antarctique, revue ensuite par Gravier (1911), Monro (1930) et Fauvel (1953), de l'antarctique et des îles Kerguélen. En 1907, Gravier avait décrit, de Port Charcot, une *Rh. antarctica* en très mauvais état qu'il reconnut plus tard identique à *Rh. intermedia*. La *Rh. attenuata* de Verrill, autant qu'on peut en juger d'après sa description, ne semble différer en rien de *Rh. loveni*. Quand à la *Rh. intermedia*, Monro (1930, p. 70) conclut: "Finally *Rh. intermedia* does not seem to be clearly distinguished from *Rh. loveni*".

En effet *Rh. loveni*, *Rh. gracilior* et *Rh. intermedia* ne diffèrent guère que par la

longueur relative des segments et par le bord des collerettes plus ou moins sinueux ou échancrés, caractère variable et bien peu important. Nous avons déjà vu que la *Rhodine sima* Ehlers n'en est qu'un individu en régénération antérieure. Il ne semble donc exister qu'une seule espèce, la *Rhodine loveni.*

Si maintenant nous en examinons la répartition géographique nous voyons que les variétés *typica* et *gracilior* sont réparties dans les mers nordiques, en Suède, Norvège, Danemark, Ecosse, îles Féroë, Groënland, New Jersey, et la variété *intermedia* dans l'Antarctique et aux îles Kerguélen. La *Rhodine loveni* existe en outre dans les régions tropicales: golfe du Mexique (Ehlers 1887, *Rh. sima*), sur les côtes de la Somalie Italienne (Ehlers 1908, p. 134), aux Indes Néerlandaises, Expédition du "Siboga", Java, mer de Bali, mer de Florés, détroit de Macassar (Mesnil et Fauvel 1939, p. 13, fig. 8).

Le passage de cette espèce de la Mer Rouge en Méditerranée, sur les côtes d'Israël, par le Canal de Suez, est infiniment plus probable que son introduction par Gibraltar en provenance du Golfe du Mexique ou des mers Arctiques.

Nous avons déjà signalé (Fauvel 1934, 1940) dans l'Adriatique un Maldanien du Japon et des Indes Néerlandaises, l'*Asychis gotoi* Izuka qui a dû pénétrer aussi par la même voie. Ces deux Maldaniens sont donc à ajouter aux espèces déjà assez nombreuses passées de la Mer Rouge à la Méditerranée par le Canal de Suez.

STERNASPIDIDAE

Sternaspis scutata Ranzani. N° 285. Un spécimen.

AMPHARETIDAE

Amphicteis gunneri Sars. N° 110. Un spécimen et un débris.
Sabellides octocirrata Sars. N° 110. Un très petit individu.
Melinna palmata Grube. N° 110, 268. Trois petits spécimens.

TEREBELLIDAE

Nicolea venustula (Montagu). N° 268. Un petit spécimen.
Pista cristata Mueller. N° 110, 268, 278. Trois petits spécimens.
Trichobranchus glacialis Malmgren. N° 268. Un petit spécimen, tentacules et branchies tombés, mais soies et uncini caractéristiques.
Terebellides stroemi Sars. N° 110. Un petit spécimen.
Polymnia nebulosa (Montagu). N° 268.

SABELLIDAE

Potamilla torelli Malmgren. N° 110. Une petite.
Myxicola aesthetica Claparède. N° 268. Un petit spécimen entier.

SERPULIDAE

Vermiliopsis richardi Fauvel. N° 278. Un spécimen, en bon état.
Cette espèce, assez rare, est nettement caractérisée par son opercule calcaire, cylindrique, dentelé et son tube percé de canaux longitudinaux. Elle a été rencontrée à Monaco (Fauvel 1909,p. 62), à Naples (Iroso 1921) et dans le golfe de Guinée (Monro, variété *fauveli*, 1930, p. 212, fig. 89).

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THE EFFECT OF DENSITY ON THE LARVAE OF A MOSQUITO AND ITS INFLUENCE ON FECUNDITY*

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ABSTRACT

Larvae of *A. aegypti*, reared at relatively low food (yeast) concentration, develop slowly. Above a certain minimum amount, however, the food has no effect on growth. When excess food is present, the mortality of the larvae is high as a result of the development of a film of yeast on the water surface, unless the water is renewed frequently.

Larvae reared under crowded and non-crowded conditions, but with the same amount of food per larva, showed similar growth rate and mortality, provided that the water was renewed to prevent development of the yeast film. There was found to be no effect of any metabolites on the development or mortality. Delayed development of the larvae under crowded conditions was found to be due to lack of food.

Antibiotics enhance the development of larvae at low, and delay it at normal concentrations of food.

Larvae reared under starving conditions yield adults of lower fecundity and smaller size than larvae reared under normal food conditions. The cause, or one of the causes, of the lower fecundity is the lower amount of blood ingested by females reared under starving conditions.

It has long been recognized that overcrowding has a detrimental effect on animals which manifests itself in various ways: slower growth rate, increased mortality, smaller adults, lower fecundity, etc. Pearl and Parker (1922) and Bodenheimer (1936) observed decreased fecundity with increasing crowding in *Drosophila melanogaster*. Similar results were obtained by Chapman (1928), MacLagan and Dunn (1936), and Crombie (1942) with several species of grain infesting insects. As far as mosquitoes are concerned, Shannon and Putnam (1934) observed a slower growth rate and higher mortality of *Aedes aegypti* under crowded conditions. Similar observations were reported by Terzian and Stahler (1949) on *Anopheles quadrimaculatus*. They also observed that pupae from underpopulated colonies were larger and heavier than pupae from overpopulated colonies. These investigators attributed the effect mainly to the mechanical disturbance of the insects by each other. Contrary to this conclusion, Robertson and Sang (1944) demonstrated that the fecundity of *D. melanogaster* depended on the quantity and quality of food,

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and that the decreased fecundity under crowded conditions was due to lack of food. These results have been confirmed by Bodenheimer (1955).

The object of the present study was to reinvestigate this problem with larvae of *A. aegypti* (local strain), which can be easily reared in the laboratory, and to determine whether competition for food or other factors determine the detrimental effect on the larvae under crowded conditions. Larvae were reared under different crowded and non-crowded conditions, keeping the amount of food per larva constant, and the growth rate and mortality of the larvae were compared. Since bacteria develop in the water culture, and change the amount of food available to the larvae, it was necessary to prevent bacterial growth. This was achieved by the addition of penicillin and chloromycetin to the water culture. Thus, it became important to study initially (a) the effect of the antibiotics on larval growth rate and mortality, (b) the degree of microbial sterility of the water culture, following the use of antibiotics, (c) the effect of different amounts of food on larval growth rate.

MATERIALS AND METHODS

Five groups of 30 newly hatched larvae each were introduced in 100 ml tap water, contained in Erlenmeyer flasks of 250 ml, and baker's yeast (Paca Co., Tel Aviv) was added in increasing quantities, divided into two equal portions which were supplied at an interval of 3 days. Every second day, 100 units penicillin (Rafa Laboratories, Jerusalem) and 20 γ chloromycetin (Parke, Davis & Co., Detroit, Mich.) per ml were added to each container. As controls, 5 groups of larvae were fed similarly, but without the addition of antibiotics. The day on which pupation occurred was recorded, and the number of larvae pupating thereafter was counted. The average pupation (weighted mean) per day was thus determined. After pupation was completed, the number of bacteria in the water culture was counted.

The temperature (as indicated in each table) and, therefore, the growth rate in different experiments varied. To each experiment, however, a control test was carried out simultaneously and at the same temperature.

RESULTS

Above a certain minimum amount (0.600 gm yeast per group of 30 larvae), the quantity of food had no effect on growth rate. The antibiotics (at normal food concentrations) delayed the development of the larvae, but had no effect on their mortality. Development proceeded uniformly, and the adults obtained were normal. When the quantity of food was small, the growth rate was greatly lowered. At very low concentrations of yeast (0.1—0.2 gm per 30 larvae) it was observed that development proceeded better in the *presence* of antibiotics (Table I and Figure 1). Further experiments at a concentration of 0.1 gm yeast per 30 larvae were carried out, which verified this observation (Table II).

TABLE I

The effect of the amount of yeast on growth rate and mortality of larvae with and without addition of penicillin and chloromycetin (aver. temp. 24° C)

A. With penicillin and chloromycetin

Group No.	Total quantity of yeast (gm)	Number of larvae	Days to first pupation	Days to final pupation	Average pupation (days)	Mortality	
						Larvae	Pupae
1	0.1	30	12	33	22.1	6	0
2	0.2	30	12	29	19.7	4	4
3	0.6	30	11	20	14.9	3	3
4	1.0	30	10	21	14.9	1	1
5	1.4	30	10	21	15.1	2	1

B. Without penicillin and chloromycetin

1	0.1	30	—	—	—	30*	—
2	0.2	30	19	40	30.0	24*	2
3	0.6	30	7	11	9.7	10	0
4	1.0	30	7	10	9.2	3	0
5	1.4	30	7	10	8.7	6	0

* Larvae died in the first and second stage.

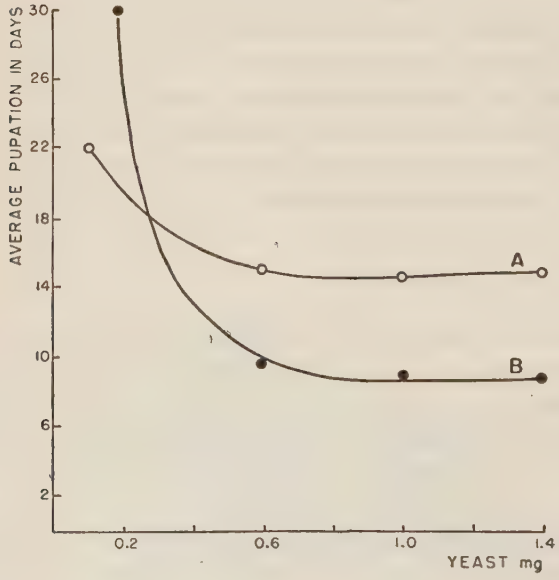

Figure 1
Growth rate of larvae at different amounts of yeast (A) with and (B) without penicillin and chloromycetin.

TABLE II

The effect of antibiotics on larval growth rate and mortality at low concentrations of yeast (aver. temp. 28°C)

A. With penicillin and chloromycetin

Group No.	Total quantity of yeast (gm)	Number of larvae	Days to first pupation	Days to final pupation	Average pupation (days)	Mortality	
						Larvae	Pupae
1	0.1	30	11	19	14.8	0	3
2	0.1	30	8	22	12.8	4	1
3	0.1	30	10	20	14.3	1	1

B. Without penicillin and chloromecytin

1	0.1	30	12	26	17.8	25	1
2	0.1	30	12	32	19.2	23	0
3	0.1	30	11	30	18.3	13	0

The water culture without the antibiotics was found to contain 8.6×10^6 bacteria per ml, while the one containing antibiotics showed 2×10^2 bacteria per ml or less. Although the use of these antibiotics does not insure sterility in a bacteriological sense, the remaining number of bacteria is so small that they may be assumed not to contribute to the nutrition of the larvae. Furthermore, if the bacterial flora is constant in all experiments, it will probably affect the conditions equally in all cases.

Effect of crowding on growth rate and mortality

Experiments were performed in which the number of larvae was gradually increased, using the same technique and antibiotics as before, and keeping the volume of water (100 ml) and the amount of food per larva constant. However, a difficulty encountered in these experiments was the formation of a film on the water surface when relatively large amount of food were added. Within a few days, an overgrowth of moulds developed on the film. The latter, which was found to consist mostly of yeast, caused larvae and pupae to die, most probably by interference with their normal respiration. Such a film of yeast was also formed when excess of other food (bread crumbs) was given instead of baker's yeast. When the amount of food was not too high, and, therefore, no film was formed, there was no undue mortality under crowded conditions; however, the development of the larvae was greatly delayed.

In order to overcome this difficulty, the larvae were collected every second day by filtration and transferred to 100 ml of fresh water with the addition of yeast and antibiotics as used previously. Each experiment was performed in duplicate. Results are given in Table III, experiments A, B, C, D.

TABLE III

Effect of larval density on growth rate and mortality of larvae

Group No.	Yeast (gm) after each filtration	Number of larvae in 100 ml water	Days to first pupation	Days to final pupation	Average pupation (days)	Mortality	
						Larvae	Pupae
Experiment A (aver. temp. 28°C)							
1	0.200	30	9	13	10.4	1	6
1a	0.200	30	8	11	9.6	0	11
2	0.400	60	9	15	11.8	3	10
2a	0.400	60	9	14	11.1	0	13
3	0.600	90	9	15	11.5	1	22
3a	0.600	90	8	14	10.7	0	27
4	0.800	120	9	17	11.9	4	14
4a	0.800	120	9	14	10.9	2	26
5	1.000	150	8	15	11.1	5	29
5a	1.000	150	8	17	12.1	4	33
6	1.200	180	9	15	11.3	7	35
6a	1.200	180	8	15	10.4	7	27
Experiment B (aver. temp. 32°C)							
1	0.200	30	5	10	6.1	3	2
1a	0.200	30	5	8	5.3	2	0
2	0.600	90	4	8	5.5	0	8
3	1.000	150	4	10	5.5	0	10
3a	1.000	150	4	8	5.5	0	4
4	1.400	210	4	8	4.3	10	6
4a	1.400	210	5	8	4.3	0	19
5	1.800	270	4	7	4.4	0	13
5a	1.800	270	5	8	5.4	0	7
6	2.200	330	4	10	5.5	0	31
6a	2.200	330	4	10	5.5	0	31
Experiment C (aver. temp. 30°C)							
1	2.000	600	8	13	8.3	0	7
1a	2.000	600	8	13	7.3	9	7
Control							
1	0.100	30	7	12	8.7	0	0
1a	0.100	30	7	11	8.5	0	0
Experiment D (aver. temp. 30°C)							
1	2.000	1000	6	13	8.7	4	9
1a	2.000	1000	6	13	8.3	4	3
Control							
1	0.200	100	6	10	7.4	1	0
1a	0.200	100	6	10	6.9	0	0

It can now be seen that increased crowding has no effect on the growth rate nor on the mortality of the larvae. Therefore, the crowding did not exert any *mechanical* influence on the larvae.

Possible effect of metabolic waste products

As the larvae in the foregoing experiments were transferred frequently to clean water, a possible effect of accumulating metabolites could not be detected. The following experiments were, therefore, carried out in order to determine whether such metabolic products have any effect on the larval development.

About 2000 larvae were reared in 100 ml tap water with the daily addition of small amounts of yeast. When pupation began (after about 12 days), the larvae were filtered from the water and the latter passed through a Seitz sterilizing filter, to remove bacteria or yeast. 30 newly hatched larvae were introduced into the water so conditioned and 30 others into ordinary tap water (control). Both groups were fed with 0.600 gm yeast, divided into two equal portions which were supplied at an interval of 3 days (Table IV).

TABLE IV

Growth rate and mortality of larvae in "conditioned" water and tap water (aver. temp. 25°C)

A. Conditioned water

Group No.	Total amount of yeast (gm)	Number of larvae	Days to first pupation	Days to final pupation	Average pupation (days)	Mortality	
						Larvae	Pupae
1	0.600	30	6	9	7.7	0	0
1a	0.600	30	6	9	8.1	0	0

B. Tap water

1	0.600	30	6	9	7.8	0	0
1a	0.600	30	6	9	7.8	0	0

There was no difference in growth rate or mortality in the two cases. It remained, however, possible that some *unstable* metabolites had formed, and thus their effect could not be detected. About 100 newly hatched larvae were, therefore, transferred *daily* to "new" conditioned water, i.e. water prepared as previously from which the larvae had just been taken out. In comparison, 100 newly hatched larvae were transferred daily to ordinary tap water (Table V).

Again no difference was found in growth rate or mortality of the larvae in the two cases.

TABLE V

Growth rate and mortality of larvae transferred daily to "new conditioned" water as compared to tap water (aver. temp. 23°C)

A. Conditioned water

Group No.	Total amount of yeast (gm)	Number of larvae	Days to first pupation	Days to final pupation	Average pupation (days)	Mortality	
						Larvae	Pupae
1	2.000	100	6	15	9.6	0	2
1a	2.000	100	6	16	10.2	0	2
			B. Tap water				
1	2.000	100	8	16	11.2	0	0
1a	2.000	100	8	16	11.0	0	2

The effect of larval food on the fecundity of A. aegypti

As mentioned previously, the fecundity (number of eggs produced per adult) of *Drosophila melanogaster* is reduced under crowded conditions as the result of lack of food (Robertson and Sang 1944). The effect of larval food on the fecundity of several species of Diptera has been studied by MacKerras (1933), Bodenheimer (1955) and Mathis (1938). The latter showed that larvae of *A. aegypti* derived from larvae fed on a rich or abundant diet laid more eggs that those from larvae fed on a poor diet or from larvae collected in nature and reared in their natural medium. Roy (1936) showed that more eggs were laid after the ingestion of larger amounts of blood. The following experiments were carried out in order to determine whether the amount of larval food affects the fecundity of *A. aegypti.*

A group of 30 newly hatched larvae in 100 ml water was reared under conditions of starvation, adding a small amount of yeast (20 mg) every 4—5 days. A similar group was reared under normal food conditions (600 mg in two portions). The adults of the two groups were given a blood meal. 48 hours later, 15 females of each group were dissected under a binocular microscope, and the number of eggs in them was counted. In 15 experiments, the average number of eggs per female was 57.7 ± 2.6 and 111.2 ± 4.8, respectively, in the two groups. The number of eggs produced by females reared under conditions of starvation was thus highly significantly lower ($P > 0.01$) than in females reared under normal food conditions.

Since Roy (1936) showed, as mentioned above, a relation between the amount of blood ingested and the number of eggs laid, it was interesting to determine whether there is any difference in the amount of blood ingested between females reared under conditions of starvation, and females reared under normal food conditions. 12 females of each group were weighed each before and after their first blood meal. The average weight of a female reared under conditions of starvation was 1.3 ± 0.07

mg, and the amount of blood ingested was 0.8 ± 0.07 mg, while the average weight of a female reared under normal food conditions was 2.4 ± 0.09 mg, and the amount of blood ingested was 2.0 ± 0.16 mg. The amount of blood ingested and the weight of females reared under conditions of starvation was thus highly significantly ($P > 0.01$) lower than the values obtained for females reared under normal conditions.

DISCUSSION

The experiments reported indicate that, under crowded conditions, larvae of *A. aegypti* exert on each other no mechanical effect which may interfere with their normal development. Furthermore, no deleterious effects of any metabolites were found. The growth rate was normal, provided that the amount of food per larva was adequate, and that the water was renewed so as to prevent the development of a film of yeast. It can, therefore, be concluded that the inhibitory effect of crowded conditions on larval development is due to lack of food (as observed in the experiments in which insufficient food was present).

If relatively large amounts of food are added, high or complete mortality appears as soon as a film of yeast is formed on the water surface, probably due to interference with the normal respiration of the larvae. However, additional factors may be responsible for high mortality under these conditions, such as changes in the physical and chemical properties of the water. Under normal food conditions, the larvae prevent the development of such a film, most probably by feeding on the yeast. This can be seen by comparing water containing food *and* larvae, with water containing food only. When an excess of food is present, the yeast develops faster than the larvae can cope with it.

The observations on the effect of antibiotics on the growth rate are rather surprising. The enhancement of the growth rate of larvae by antibiotics when the amount of food is low, is strikingly similar to the well-known enhancement of the growth of mammals or birds by antibiotics. One explanation offered by Jukes and Williams (1953), that "antibiotics inhibit organisms which compete with the host for available nutrients", may also be applicable to the larvae of mosquitoes. At low food concentrations, such a competition would obviously have the greatest effect on growth rate, provided that the nutritional value of the original food is higher than that of the bacteria grown on it (which also serve as food to the larvae). As to the effect of antibiotics at normal food concentrations, the delay in the growth rate may be due to the inhibition of organisms which, according to Budington (1941) and others, support the growth of mosquito larvae under these conditions.

The lower fecundity and smaller size of *A. aegypti* when reared under starving conditions show that the amount of food available to the larvae is an important factor in determining the fecundity of the adults and their size. The cause, or one of the causes, for the lower fecundity is the lower amount of blood ingested by females reared under starving conditions, and this is possibly a result of their smaller size. It can, therefore, be expected that under crowded conditions, when

the amount of food is inadequate, the larvae will yield adults of lower fecundity and smaller size. This may explain the results of previous studies on the influence of crowding on the fecundity of insects and on their size, in which no particular attention had been paid to the provision of sufficient food to the larvae.

ACKNOWLEDGMENT

I wish to express my thanks to Professor F. S. Bodenheimer for his interest and suggestions throughout this work. I would also like to thank Dr. S. Davidovitch, who has carried out bacterial counts of the water cultures.

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NEW MELOIDAE (COLEOPTERA) FROM ISRAEL

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ABSTRACT

Records are given of 4 species of eremic origin new to the fauna of Israel.

The following species and forms are described as new: *Teratolytta bytinskii* sp. nov. and *ab. jodina* ab. nov.; *Zonitis bytinskii* sp. nov.

Dr. H. Bytinski-Salz kindly sent me for revision and determination his rich collection of Meloidae gathered in various parts of Israel. The investigation resulted in some very interesting faunal data as well as in two new species which are described below. The types of both of the new species are in the collection of Dr. Bytinski-Salz, paratypes also in the collection of the Hungarian Museum of National Sciences in Budapest. I wish to express here my sincerest gratitude for the gift of the documentary specimens.

The following species are new for the fauna of Israel:

Lyttonix bilateralis Mars.

A small series from Bat Yam, 10.V, 29.V, leg. Bytinski-Salz.

This species was hitherto known only from Arabia, Egypt, Nubia, and the Algerian and Tunisian parts of the Sahara. A genuine eremophile species of Meloidae.

Diaphorocera hemprichi Heyden

1 ♂♀ Gvulot, 18.IV, 1 ♂ Urim, 7.IV, leg. Bytinski-Salz.

Hitherto known only from Egypt. Again a species of semi-deserts and sand steppes.

Sitarobrachys brevipennis Reitt

1 ♂ from Wadi Faria, hatched from a *Chalicodoma* nest, 7.II.1947, leg. Bytinski-Salz.

This species has hitherto been found in the Balkan countries and the Sahara from Egypt to Morocco, but is extremely rare.

Zonitopsis pallidissima Reitt.

1 ♂♀ from 'Ein Hatseva, 12.X.1953, leg. L. Fishelsohn.

Reitter described this species from Egypt. This, too, is a desert species. The occurrence in Israel, though not striking, is very interesting.

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Teratolytta **bytinskii** sp. nov.

Shape and form as *T. dives* Brullé, but smaller on the average. Dorsal parts bright metallic green, ventral parts also green, but the sides of the abdomen somewhat copper coloured, antennae black, legs with all trochanters yellow, palpi yellow, maxilla metallic green at the basis, yellow at the end. The whole body is covered with long, erect, greyish-white hairs.

Head broad, trapezoidal, genae elongated towards the rear, posterior part of the head terminating abruptly, corners of the genae broadly rounded. Eyes reniform, strongly arched, frons steeply declining, clypeal suture depressed. Dorsal part coarsely punctate, very rugose between the points.

Antennae of the male longer than half the length of the body; the 1st joint button-shaped, the 2nd short and wider than long, the 3rd elongated, twice as long as wide, joints from the 4th on longer, gradually scarcely tapering toward the end, the terminal joint nearly twice as long as the 3rd, pointed.

Thorax wider by one third than long, in the anterior third as wide as the head, then abruptly constricted towards the front, base narrowed with a slight curvature. Base medially sinuose, disc in front of the base and the median line depressed. Integument very rugose, with coarse points. Scutellum broad, semicircular, flat, finely and densely punctate.

The elytrae broadest in their posterior part where they are twice as broad as the thorax, length more than twice the total width at the basis, with strongly protruding, rounded shoulders. Elytrae rather flat, bent downwards only at the sides of the basis, where the lateral edges cannot be seen from above. Dorsal part coarsely and densely transverse-rugose, sparsely covered with erect hairs, but the tip and lateral edges densely covered with greyish-white hairs. Under side very slightly rugose with rasp-like grains, meta-sternum near the middle coxae on each side of its anterior part with a strongly elevated, elongated tubercle which is densely covered with black bristles. The end of the last sternite deeply excised with acute corners, both sides apically covered with long black steae. The last tergite apically scarcely excised.

Fore tibiae thin and rounded, distally somewhat thicker and very slightly bent, with few erect bristly setae. Middle tibiae of the male excavate at the internal end, below in the distal third is a sharp spur pointing backwards with setae at its end. Internal face excavate at the end and curved inwards, the excavation tooth-like elongated with the inner end-spine at its apex. Hind tibiae slender and long. Internal side somewhat S-shaped. The outer terminal spur of the hind tibiae twice as wide as the inner spine, apically rounded, very obliquely cut. Fore and hind tarsi simple. The first segment of the middle tarsi enlarged, knee-like, inner side covered with black bristles, ventral side apically densely covered with yellow hairs. Femora and trochanters of the fore and middle legs simple, base of hind femora broad and keel-shaped above; hind trochanters each with a naked lamella pointing downwards, with parallel sides and rounded apex.

Length: 9—13 mm. Breadth: 3.4—5 mm.

10 identical ♂♂ and 5 ♀♀ from Israel: Daphne Oaks, 4.III.1942, on *Quercus*, leg. Bytinski-Salz (holotype ♂ and allotype ♀, as well as paratypes), moreover 2 specimens from Tel Aviv, 21.IV, Ramat Rahel, 24.I (paratypes).

Named in honour of its discoverer, Dr. H. Bytinski-Salz, Tel Aviv.

This species is close to *T. dives* Brullé and *T. gentilis* J. Friv. (= *T. coensis* J. Müll.), which are of similar shape and sculpture. However, there are important differences particularly in the males, which allow the three species to be easily distinguished with certainty. The hind trochanters of the male are naked in *T. bytinskii* sp. nov., but possess a long, black, curved brush of setae in *T. dives* Brullé; moreover, all trochanters in *T. dives* Brullé are blue-black. *T. gentilis* J. Friv. differs from *T. bytinskii* sp. nov. by the absence of tubercles on the meta-sternum and by its trochanters also being blue-black. Distinctly separate from all *Teratolytta* species so far described.

Teratolytta bytinskii ab. **jodina** ab. nov. As the parent form, but blue body, black antennae and reddish-yellow legs.

1 ♂ from Israel: Daphne Oaks, 4.III.1942, on *Quercus*, leg. Bytinski-Salz (holotype).

Zonitis **bytinskii** sp. nov.

Body elongated, very lucid, dorsal side nearly naked. Dorsal and ventral side reddish-yellow, the end of the elytrae, as well as antennae and legs black; tarsi, end of antennae and palpi brown; basis of femora, trochanters and coxae reddish-yellow. Head somewhat darker brownish yellow.

Head rounded, genae short, parallel, and forming a broad arc with the occiput. Front flat between the eyes, above and the occiput arched, clypeal suture not depressed, clypeus trapezoidal, strongly narrowed toward the anterior part, labrum narrow at the basis, widened towards the front, edge rounded, approximately as long as wide. Front between the eyes as wide as between the insertion of the antenna. Head without antennal sockets. Eyes kidney-shaped, flat and finely facetted. Dorsal part sparsely and finely punctate, apparently bald.

Antennae filiform, the 2nd joint 1.5 times as long as wide, the 3rd thin and its sides nearly parallel, with oblique end, twice as long as the 2nd joint, the 4th, 5th and 6th joint each as long as the 3rd, but more slender; from the 7th the joints are shorter, the last joint much shorter than the 3rd, thin and pointed. The last segment of the maxillary palpi short and parallel, obliquely truncate, dorsally with a longitudinal depression.

Thorax longer by one third than wide, from the basis past the middle with parallel sides, then sinuously constricted, anterior edge broadly rounded. Disc transversely arched, with very few scattered points, lucid and glossy, completely bald.

Scutellum semicircular, flat, densely and finely punctate, pilose.

Elytrae are 1.5 times as broad as the thorax, with rounded shoulders, humeral calli weakly defined at the inside; elytrae parallel, ends gaping, and each tip indivi-

dually rounded. Disc highly arched so that the lateral edges cannot be seen from above. Integument smooth, with few points which become smaller towards the rear. Sparse, erect and backwards pointing hairs of greyish-yellow colour. Ventral part glossy, densely covered with yellow tomentum.

Legs simple, tibiae thick, straight and rounded, the outer terminal spur of the hind legs slightly thicker than the inner spur. Tarsi thin and simple, the first segment of the hind tarsi approximately as long as the last.

Length: 7 mm. Width: 2.5 mm.

3 identical ♀♀ from Israel: Asluj, 8.VII.—4.VIII. 1945, leg. Bytinski-Salz (holo- and paratype).

I take the liberty to name this new and interesting species in honour of Dr. H. Bytinski-Salz.

This species has no relatives among the palaearctic species of *Zonitis*, all of which have a broad and nearly parallel thorax. The species is near the African species *Z. zavattarii* Kasz., *Z. sternalis* Kasz. and *Z. kittenbergeri* Kasz. But *Z. zavattarii* Kasz. has yellow tip of the elytra, yellow legs and the 1st joint of the antennae is also yellow; *Z. sternalis* Kasz. and *Z. kittenbergeri* Kasz. have a black head, a mostly black abdomen and entirely black femora and coxae, and their dorsal part is much more heavily punctate.

ADDITIONS TO THE FAUNA OF ACARINA OF ISRAEL (EXCLUDING TICKS AND GALL MITES)

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ABSTRACT

This list adds 47 genera and 32 species of Acarina to those previously known from Israel (25 genera and 24 species); the majority have been identified by Dr. F. A. Turk of Camborne, England.

The study of Acarina in Israel has been chiefly concentrated on those of medical (Ixodidae) and agricultural (Tetranychidae, Eriophyidae) importance, though the fresh water mites of Lake Tiberias and Lake Hula were enumerated by Koenicke (1894/95).

Bodenheimer (1937) mentions 25 genera and 24 species of these groups, but otherwise the rest of the families of the Mesostigmata, Trombidiformes, and Sarcoptiformes have been rather neglected.

The author started collecting mites several years ago, and most of the material mentioned in this paper was determined by Dr. F. A. Turk of Camborne, England, for whose valuable help the author expresses his sincere gratitude. Part of the material was collected also by Prof. G. Haas, Prof. O. Theodor, Mr. J. Palmoni, Mr. J. Wahrman, and Dr. A. Moscona, who kindly placed it at the author's disposal.

The following list adds 47 genera and 32 species (indicated by an asterisk) to those known previously. These additions, however, probably represent only a small part of the Acaro-fauna of Israel.

The new species mentioned in the list will be described by Dr. F. A. Turk and by Mr. K.M. Jack, London (Pterygosomidae).

In compiling the list the reference books were: Piersig and Lohman (1901), Bodenheimer (1935), and Baker and Wharton (1952).

SUBORDER MESOSTIGMATA

SPINTURNICIDAE

**Spinturnix vespertilionis* Scop.	Jerusalem (on bat, Theodor).
**Spinturnix acuminatus* Koch.	Yesod Hama'ala, 10.V.46 (on *Pipistrellus kuhlii* Natt.); Tel Aviv, 1.VIII.36 (on bat).

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ASCAIDAE

**Cyrtolaelaps* sp.	Jerusalem, 19.V.43 (nymph) (on eggs of *Dociostaurus maroccanus* Thnbg).

PARASITIDAE

**Parasitus lunaris* Berl.	Beit Ha'arava, 6.XII.42, 7.VI.45 (on roots of *Rosa*); Jerusalem 1.V.35 (on brood of *Phlebotomus*, Theodor; on young *Gerbillus*, Theodor)
Parasitus coleoptratorum Linn.	Bod. (1937).
**Eugamasus* sp.	Geva', 5.II.37 (on *Copris hispanus* L.).

MACROCHELIDAE

**Coprholaspis* sp.	Jerusalem, 1946 (Moscona).
**Nothrholaspis vagabundus* Berl.	Jerusalem, 19.V.43 (on eggs of *Dociostaurus maroccanus* Thnbg).

PACHYLAELAPTIDAE

**Pachylaelaps* sp.	Geva', 5.II.37 (nymph) (on *Copris hispanus* L.).

GAMASOLAELAPTIDAE

**Gamasodes spiniger* Ouds.	Jerusalem, 19.V.43 (on eggs of *Dociostaurus maroccanus* Thnbg).

DERMANYSSIDAE

Dermanyssus gallinae Deg.	Bod. (1937).
**Ophionyssus natricis* Gerv.	Tel Aviv, 1.IV.45 (on snakes).

PHYTOSEIIDAE

**Zercoseius podocinoides* Berl.	Jerusalem, 1.IV.45 (on *Gladiolus* bulbs).

LAELAPTIDAE

Gymnolaelaps myrmecophilus Berl.	Bod. (1937).
Pneumolaelaps* **n. sp.	Pardess Hanna, 23.VII.44 (on *Xylocopa* sp.).
**Dinogamasus braunsi* Vitz.	Jerusalem, 1946 (Wahrman).
**Dinogamasus braunsi* Vitz. var. Form possibly *inflatus* Leveque.	Jerusalem, 1946 (Wahrman).

UROPODIDAE

**Uropoda obscura* Koch.	Jerusalem, 26.II.41 (on *Aphodius* sp.).

ANTENNOPHORIDAE

**Antennophorus pubescens* Wasm.	Jerusalem, 15.I.47.

PARAMEGISTIDAE

**Neomegistus* sp. near *julidicola* Traeg.	Poriya, 21.III.44.

SUBORDER TROMBIDIFORMES

PODAPOLIPODIDAE

Podapolipus aharonii Hirst.	Bod. (1937).

PYEMOTIDAE

Pyemotes (=*Dediculoides*) *ventricosus* Newp.	Bod. (1937).

EUPODIDAE

**Linopodes motatorius* Linn.	Jerusalem-Jericho road, 9.IV.37.

BDELLIDAE

**Bdella longicornis* Linn.	Jerusalem, 17.II.41 (under stones).
**Bdellodes longirostris* Herm.	Deganya, 8.III.40 (under stones, Palmoni).
**Neomolgus lacustris* Hull.	Jerusalem, 19.XII.35.
**Hoplomolgus capillata* Berl.	Ben Shemen, 15.V.44; Jerusalem, 29.I.36 (on *Malva*), 29.I.43, 1.IV.44; Jericho, 10.II.45; Kfar 'Etsyon, 6.I.44; Ma'oz, 29.I.43; Wadi Kelt, 1.IX.45.

RHAGIDIIDAE

**Rhagidia* sp.	Wadi Kelt, 13.I.43.

RAPHIGNATHIDAE

Neophyllobius* **n. sp.	Jerusalem, 29.XII.46.

PTERYGOSOMIDAE

Pterygosoma* **n. sp.	Jerusalem, 1.III.37.

CAECULIDAE

**Caeculus echinops* Duf.	Mishmar Ha'emeq, 3.XI.44.

TETRANYCHIDAE

Tetranychus urticae Koch (=*altheae* Hanst.).	Bod. (1937).
Anychus orientalis Zach.	Bod. (1937).
Bryobia praetiosa Koch.	Bod. (1937).
Bryobia sp. perhaps *urticae* Sayeed.	Jerusalem, 18.XII.36 (on *Malva*).

PHYTOPTIPALPIDAE

Tenuipalpus geisenheyneri Ruebs (=*bodenheimeri* Berl. in litt.).	Bod. (1937).

ANYSTIDAE

Anystis baccarum Linn. — 'Atlit, 19.III.44; Sha'ar Hagai, 23.VI.43; Mt. Carmel, 4.IV.44 (on *Matsucoccus*); Mt. Cana'an, 4.IX.44; Dalya, 13.III.45;, Jerusalem, V.39, 4.V.42, 15.V.43, 26.IV.44, V.44 (Mt. Scopus, Botanical Garden); Jerusalem-Jericho Road, 13.II.39; Rosh Pina, 6.III.37 (on *Rhinolophus* sp.); Zikhron Ya'aqov, 23.III.46.

Chaussieria (=*Schellenbergia*) *flava* Dug. — 'Ein Feshgha, 9.XII.45.

Tarsotomus callunae Oud. — Avihayil, 10.III.39.

CHEYLETIDAE

Cheyletiella sp. — Beit Oren, 1.IX.44.

ERYTHRAEIDAE

**Erythraeus phalangoides* Deg. — Ben Shemen, 15.V.44.

**Erythraeus* sp. near *phalangoides* Deg. — Jerusalem, 16.III.44; Manara, 6.IX.44.

Erythraeus sp. — Bod. (1937).

**Balaustium* sp. — Jordan bank, 10.I.43; Qishon bank, 10.I.43; Susita, 13.IV.40 (on rocks).

**Leptus* sp. — 'Ein Harod, 5.X.51.

Sphaerolophus* **n. sp. — Beit Yosef, 4.I.40.

SMARIDIIDAE

Hirstiosoma* **n. sp. — Eilon, 21.VII.44; Qiryat 'Anavim, 30.I.40 (in bark of Oak); Wadi Kelt 1.IX.45.

TROMBIDIIDAE

Johnstoniana* **n. sp. — Dalya, 13.III.45.

**Microtrombidium* sp. — Kfar 'Etsyon, 6.I.44.

TROMBICULIDAE

Leptotrombidium* **n. sp. — Jerusalem, 19.IV.44.

HYDRACHNIDAE

Hydrachna (=*Atax*) *crassipes* Muell. — Bod. (1937).

EYLAIDAE

Eylais extendens Muell. — Bod. (1937).

**Eylais rimosa* Piersig. — Jerusalem, Beit Hakerem, 28.III.46 (adult); 'Ein Feshgha, 19.III.43 (larva) (in pools).

**Eylais limnophila* Koen. — Jerusalem, winter 1945 (in pools).

SPERCHONIDAE

Sperchon denticulatus Koen.	Kfar Gil'adi, 5.IX.44 (in pool).

HYGROBATIDAE

Hygrobates longipalpis Herm.	Bod. (1937).

PIONIDAE

Piona (=*Curvipes*) *nodata* Muell.	Bod. (1937).
Piona rotundata Kram.	Bod. (1937).
Piona carnea Koch (=*alpina* Neum.).	Bod. (1937).
Acercus sp.	Bod. (1937).

ARRENURIDAE

Arrenurus barroisi Koen.	Bod. (1937).
Arrenurus ampliatus Koen.	Bod. (1937).

SUBORDER SARCOPTIFORMES

SUPERFAMILY ACARIDIAE

ACARIDAE (=TYROGLYPHIDAE)

**Acarus siro* Linn.	Jerusalem, 10.X.44 (hypophial nymph) (on *Strongylosoma*)
Tyrolichus (=*Tyroglyphus*) *casei* Oud.	Bod. (1937).
**Tyrophagus* (=*Coelognathus*) *putrescentiae* Schrk. (on eggs of *Schistocerca gregaria* Forsk).	Jerusalem, 1.VII.41 (on bulbs), 1.XII.46.
Rhizoglyphus echinopus Clap.	Bod. (1937).
**Caloglyphus borlesei* Mich.	Jerusalem, 9.I.46 (on eggs of *Dociostaurus maroccanus* Thnbg).

GLYCYPHAGIDAE

Glycyphagus domesticus Deg.	Bod. (1937).

SARCOPTIDAE

Sarcoptes scabiei Deg. var. *hominis* Her.+var. *canis*.	Bod. (1937).
Knemidokoptes (=*Sarcoptes*) *mutans* Rob.	Bod. (1937).

PSOROPTIDAE

**Psoroptes equi* Rasp. var. *cuniculi* Delaf.	Shulov (1943).

SUPERFAMILY ORIBATEI

NEOLIODIDAE

**Neoliodes farinosus* Koch.	Beit Oren, 1.IX.44; Eilon, 28.III.44 (under bark of trees).
**Platyliodes doderleinii* Berl.	Wadi Ruaz, 22.XII.45 (Haas).

BELBIDAE

**Belba* sp.	Beit Oren, 1.IX.44; Jerusalem, 17.XII.44, 24.XI.45.

EREMAEIDAE

**Ceratoppia bipilis* Herm.	Deganya, 12.IV.38; Jerusalem, 19.II.42.
Hydrozetes* **n. sp. near *confervae* Schrk.	Kallia, 1.VII.43 (on mosquit.o)
**Oribata geniculata* Linn.	Beit Oren, 1.IX.44.
**Oribella pectinata* Mich.	Jerusalem, 24.XI.45.

ORIBATULIDAE

Oribatula plantivaga Berl.	Bod. (1937).
Zygoribatula **n. sp.** near *propinquus* Oud.	Jerusalem, 1.III.27.

CERATOZETIDAE

**Sphaerozetes* (=*Euzetes*) *seminulum* Muell.	'Eqron, 30.VII.41.

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NOTES ON FORAMINIFERA FROM ISRAEL

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ABSTRACT

I. The distinctive characters of *Truncorotalia aragonensis caucasica* (Glaessner) are discussed It is regarded as a valid subspecies different from *Tr. velascoensis* (Cushman). The latter species is confined to the Paleocene, whole *Tr. aragonensis caucasica* ranges from higher Ypresian to Lutetian.

II. **Loxostomoides,** gen. nov. (type-species *L. applinae* (Plummer)), belonging to the Family Bolivinidae and occurring in late Cretaceous and early Tertiary deposits of both hemispheres, is described.

III. **Sigalia,** gen. nov. (type-species: *Gümbelina* (*Gümbelina, Ventilabrella*) *deflaensis* Sigal, 1952) is described. The genus is known from the Santonian (and uppermost Coniacian?) of the Eastern Tethys region.

I. REMARKS ON *TRUNCOROTALIA ARAGONENSIS CAUCASICA* (GLAESSNER)

Introduction

Since its erection by Glaessner (1937), the subspecies *Truncorotalia aragonensis caucasica* has been repeatedly confused with *Tr. velascoensis* (Cushman) and included by some authors in the synonymy of the latter.

This writer has identified in Israel (Reiss 1952) both *Tr. velascoensis* and *Tr. aragonensis caucasica*. They have been found to differ in several constant characters (most of them mentioned already by Glaessner 1936) and to have an entirely different stratigraphical range: *Tr. velascoensis* occurs very frequently in deposits of Paleocene age, *Tr. aragonensis caucasica* in deposits ranging in age from higher Lower Eocene to Middle Eocene. This writer has also examined specimens of both species from various regions of the Tethys area (from material deposited in the collection of the Geological Survey of Israel and at various laboratories during a recent UNTAA study trip to Europe) and has arrived at the same conclusions with regard to the distinctness of *Tr. aragonensis caucasica* from *Tr. velascoensis* as well as with regard to their different stratigraphical distribution. Thanks are due to M. Lys, I.F.P., Rueil-Malmaison, France, for the stimulating discussion regarding these species on the occasion of the writer's stay at the I.F.P.

Discussion

Glaessner (1937) has described *Globorotalia aragonensis* Nuttall var. *caucasica* from the Lower Eocene Koun strata of the Caucasus. He states that this variety differs

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from typical specimens of *G. velascoensis* (Cushman) by the slower increase in size of the chambers and by the slightly elevated spiral side. Furthermore, Glaessner states that young specimens of this variety correspond exactly to typical specimens of *G. aragonensis* typ. According to Grimsdale (1951), *G. aragonensis caucasica* is actually a typical *G. velascoensis;* he emphasizes, however, the different stratigraphical range. This writer does not share the opinion of Grimsdale for several reasons. In the first place, published figures of *Truncorotalia velascoensis* show that it is much less coarsely "ornamented" (walls and keels being much less coarsely granular, the latter being finer and narrower) than *Tr. aragonensis caucasica.* Glaessner states clearly that *Tr. aragonensis caucasica* is more coarsely ornamented than *Tr. aragonensis* Nuttall typ., and this latter is described by Nuttall (1930) as being more coarsely ornamented than *Tr. velascoensis*, a fact shown quite well by the figured holotypes and ascertained by this writer on the basis of rich material, including topotype material (see also Cushman and Bermudez 1949, p. 39).

Secondly, *Tr. velascoensis* has a flat or even concave spiral side and not an elevated one as in *Tr. aragonensis caucasica* (see also Glaessner 1937).

Thirdly, in specimens of *Tr. velascoensis* the chamber-ends on the umbilical side are not so very strongly curved outwards as in *Tr. aragonensis caucasica* (a constant and characteristic feature).

Furthermore, the sutural keels of *Tr. velascoensis* are much finer than those of *Tr. aragonensis caucasica*, being sometimes beaded, bending sharply at the periphery where they merge into the peripheral part of the keel, forming with the latter a distinct angle. In *Tr. aragonensis caucasica* the sutural keels are coarser and thicker than in *Tr. velascoensis*, thickening gradually towards the periphery and passing into the peripheral keel in a rounded manner, without forming a distinct angle with the latter. This important character is well demonstrated by the figured holotypes of both species (see also Cushman and Renz 1946, pl. 8, figs. 13—14).

Finally, *Tr. aragonensis caucasica* has been described from the upper(!) strata of the lower division of the Eocene-Oligocene "Untere Foraminiferenschichten" of the Caucasus and therefore from the Eocene. Glaessner lists a typically Eocene (and not Paleocene) fauna from these strata. This writer has observed *Tr. aragonensis caucasica* both in Israel and in various other places of the Tethys area always in Lower and Middle Eocene strata, but never in the Paleocene. On the other hand, *Tr. velascoensis* is one of the most important Paleocene species and no intergradation between it and *Tr. aragonensis caucasica* has been observed.

This writer fully agrees with Glaessner with regard to the derivation of *Tr. aragonensis caucasica* from *Tr. aragonensis* typ.; this opinion is supported by the occurrence of transition forms between them and by the fact that young specimens of *Tr. aragonensis caucasica* are exactly like *Tr. aragonensis* typ. (see Glaessner 1937), as well as by the stratigraphical distribution of both forms. It is noteworthy that Grimsdale (1951) gives the stratigraphical range of *Tr. velascoensis* as being Paleocene in the Middle East, but includes at the same time *Tr. aragonensis caucasica* in the

synonymy of the latter. This writer has observed *Tr. velascoensis* both in the Middle East and in other regions of the Tethys area always associated with the fauna listed by Grimsdale as characteristic for the Paleocene, but never with that listed by him as marking the Eocene, where however *Tr. aragonensis* and *Tr. aragonensis caucasica* occur.

II. *LOXOSTOMOIDES*, A NEW LATE CRETACEOUS AND EARLY TERTIARY GENUS OF FORAMINIFERA

Studies on Foraminifera from Israel and from various places in both hemispheres revealed that certain species, hitherto included in the genus *Loxostomum* Ehrenberg, possess certain characters distinctive enough to warrant the grouping of these species into a new genus, *Loxostomoides*, gen. nov., herein described.

Fam. Bolivinidae

Genus **Loxostomoides** Reiss, gen. nov.

SYNONYMY: *Bolivina* (part) of authors.
Loxostomum (part) of authors.

TYPE SPECIES: *Bolivina applini* Plummer, 1927 (recte *B. applinae*), Univ. Texas Bull. 2644, p. 69, pl. 4, fig. 1;
Loxostomum applinae (Plummer) Cushman, 1937 (pars, non *L. applinae* Nuttall, 1930 = *Bifarina nuttalli* Cushman and Siegfus, 1939), Cushman Lab. Foraminiferal Res., Spec. Public. No. 9, p. 173, pl. 20, fig. 20 a—c.

DESCRIPTION: Test elongated, narrow, slightly tapering, slightly if at all compressed, periphery rounded; chamber arrangement biserial, tending to become uniserial in the adult stages, but never so for many instars; sutures provided with retral processes ("reentrants and lobular processes", "lobes", "crenulations" of authors) at least in the adult stages; wall structure calcareous, perforate; aperture elongated elliptical to rounded ovate, normal to the basal (inner) margin of the chamber, extending to and touching this margin in most of the chambers, becoming separated from the chamber base and tending to become terminal (but never central) in later stages; tooth plate present.

RELATIONSHIPS AND REMARKS: *Loxostomoides*, gen. nov. is related to *Loxostomum* Ehrenberg, 1854 in the same way as *Bolivinoides* to *Bolivina:* in both cases the presence or absence of retral processes represent the main difference. *Loxostomoides*, gen. nov. is obviously the ancestor of such types of *Bifarina* as *B. nuttalli* Cushman and Siegfus. To *Loxostomoides*, gen. nov. belong *L. applinae* (Plummer) and *L. cushmani* (Wickenden).

OCCURRENCE: *Loxostomoides*, gen. nov. is known up to now from deposits of Senonian to Paleocene age of both hemispheres. Records of *L. applinae* from deposits of Lower Eocene age must be carefully checked, since on the one hand *B. nuttalli* might be

involved, while on the other hand the term "Lower Eocene" is used by various authors for deposits of Paleocene and even Danian age (e.g. the American Midway and Wilcox formations and their equivalents). The only species of *Loxostomoides*, gen. nov. occurring in Israel is *L. applinae* (Plummer). Its range in Israel is: uppermost Maestrichtian (extremely rare) up to the top of the Paleocene (top of the "*Pseudovalvulineria* subzone"), very frequent in the Danian and in the Paleocene.

III. *SIGALIA*, A NEW GENUS OF FORAMINIFERA

In an earlier publication (1955) this writer expressed his doubts with regard to the generic position of the species described by Sigal (1952) as *Gümbelina* (*Gümbelina*, *Ventilabrella*) *deflaensis* from the Santonian (not Coniacian, as given by Sigal 1952; see Sigal 1955) of Algeria, suggesting that it may belong to a new genus or subgenus.

Bettenstaedt and Wicher (1955) state that this species belongs definitely to the genus *Ventilabrella* and include in its synonymy the species described by de Klasz (1953) as *Ventilabrella decoratissima* and *V. alpina*. Sigal (1955) states that the two forms figured by him in 1952 as *Gümbelina* (*Gümbelina*, *Ventilabrella*) *deflaensis* belong to two different groups (plexus): one to *Gümbelina*, the other to *Ventilabrella*, the latter appearing higher in the section than the former.

This writer has examined many specimens of *G.* (*G.*, *V.*) *deflaensis* both from the Santonian of Israel (zone of *Globotruncana concavata* (Brotzen) (*Texanites* strata)) and from various Santonian deposits of the Eastern Tethys region (North Africa, Europe), and has arrived at the conclusion that this species presents certain characters distinctive enough for it to be placed in a new genus and described herein. It is named *Sigalia* in honour of J. Sigal, I.F.P., Rueil-Malmaison, for his contributions to the knowledge of Foraminifera.

Fam. Gümbelinidae

Genus **Sigalia** Reiss, gen. nov.

SYNONYMY: *Gümbelina* (part) of authors.
Ventilabrella (part) of authors.

TYPE-SPECIES: *Gümbelina* (*Gümbelina*, *Ventilabrella*) *deflaensis* Sigal, 1952, Monogr. région. Algérie, Ser. 1, No. 26, p. 36, fig. 41, 19th Int. Geol. Congr. Alger.

DESCRIPTION: Test compressed, biserial, rarely tending to add more than one chamber per series (row) in very late stages; wall structure calcareous, perforate; sutures limbate, covered by prominent rows of raised beads, giving the apertural end of each chamber a "truncated" character; aperture arched, half-moon shaped, in basal position at the inner margin of the chamber ("gümbelinid").

RELATIONSHIPS AND REMARKS: *Sigalia*, gen. nov. differs from *Gümbelina* by its raised and beaded sutures, by its rare tendency to add more than one chamber per row, and by the absence of a spiral stage; from *Ventilabrella* by its well-developed, long

biserial stage with only a rare tendency to build more than one (maximum two) chambers in a series (row) in very late stages, and by its raised and beaded sutures of all chambers; from *Pseudogümbelina* by the lack of secondary apertures; from *Bronnimannella* by the shape of its chambers, by the raised and beaded sutures, and by the lack of the characteristic ornamentation; from *Güblerina* by the lack of the "intercalated, hollow space" (espace vide intercalaire); from *Bolivinella*, which resembles *Sigalia*, by the apertural characters, in *Sigalia* and by the latter's tendency to build more than one chamber per row in late stages.

As far as *Ventilabrella decoratissima* deKlasz is concerned, it might belong p a r t l y to *Sigalia deflaensis* (Sigal). DeKlasz himself states (1953, p. 228) that m o s t l y biserial forms occur. On the other hand, he figures as holotype a specimen which shows a long biserial stage with beaded sutures, but followed already by a *Ventilabrella* stage (although short) with "spreading" chambers, lacking the beads on the sutures, which appear depressed. The figured holotype of *V. decoratissima* must be regarded, considering deKlasz' statement, as not representative of the species. It represents probably a very evolved form, transitional between *Sigalia* and *Ventilabrella*, originating in this writer's opinion from strata of late Santonian age. It should be noted that Sigal (1955) states that the *Ventilabrella* plexus appears later than the *Gümbelina* plexus of *G.* (*G., V.*) *deflaensis*. It must also be emphasized that this writer has not observed hitherto true *Ventilabrellae* in the eastern Tethys region before the late Santonian. This is true also for Israel and for North Africa. Through the kindness of J. Sigal this writer was able to examine Santonian material from North Africa containing *Sigalia deflaensis* at the Institut Français du Petrole, Rueil-Malmaison, during a recent trip to Europe on a UNTAA grant, as well as at the Geological Survey of Israel, where material from North Africa is deposited. Observations on this material show that most of the specimens of *S. deflaensis* are biserial throughout, the beads on the sutures being present in all chambers, while only extremely rare specimens from late Santonian strata show more than one chamber (maximum two) per row in very late stages and this not more than once (compare Sigal's (1952) figures and Bettenstaedt and Wicher's (1955) fig. 2).

It seems therefore that *Sigalia* is the ancestor of — at least certain types of — *Ventilabrella*. Thus *S. deflaensis* is the ancestor of *Ventilabrella decoratissima*, which in turn is probably the ancestor of *V. alpina* de Klasz, an assumption supported by their stratigraphical distribution. The origin of *Sigalia*, gen. nov. is unknown. It is probably an offshoot of a *Gümbelina*, being intermediate between *Gümbelina* and *Ventilabrella* or at least certain species of the latter.

Occurrence: *Sigalia*, gen. nov. is known up to now from the uppermost Coniacian(?) and especially from the Santonian of the eastern Tethys region (Sigal 1952, 1955, de Klasz 1953, Bettenstaedt and Wicher 1955, Reiss 1955). Only one species — *S. deflaensis* (Sigal)—has been hitherto described. In Israel *S. deflaensis* is an excellent marker for the Santonian (*Glbtr. concavata* zone, compare Sigal 1955, p. 158).

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NEW GEOLOGICAL DATA ON THE REKHME ANTICLINAL CREST

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ABSTRACT

Detailed mapping of the crestal area of the Rekhme Anticline has shed new light on the fault tectonics of the area. In addition it has made available new measured stratigraphic data, providing good correlation with Hatsera. A deep test drilled has indicated the complex nature of the subsurface. A major reverse fault was encountered at depth with over 300 m of section repeated. Good electric log correlation has been found with the Kurnub well, indicating the presence of a number of small faults in Rekhme No. 1. The exact location of the stratigraphic boundaries penetrated is still problematical pending more detailed palaeontological study. The change during Lower Cretaceous times, from a predominantly continental environment type of deposition, to more marine conditions of sedimentation, occurs somewhere between Kurnub and Rekhme.

INTRODUCTION

Since the Israel Petroleum Law came into effect in 1952, considerable geological information has been accumulated through the efforts of the various oil companies operating in Israel. Detailed geological and geophysical investigations have been executed in various parts of the country and twenty-two deep test exploratory drillings have been completed. In addition, over 200 shallow structure holes have been drilled.

For various reasons, much of the derived geological data has been of a confidential nature, having been forwarded to the Petroleum Commissioner's Office in the form of Quarterly Reports. These reports are being subjected to a complete review and analysis by the Oil Division of the Geological Survey, which will result in an integrated body of compiled geological data on a regional basis. It is hoped that, with the passage of time, most of this information will be released from the classified list and become available to all interested parties.

The purpose of this paper is to present a summary of new, significant, geological facts obtained from geological investigations carried out on the Rekhme Anticline. The author has drawn freely upon Company reports and wishes to express his appreciation to the Israel American Oil Corp., for the release of hitherto confidential information.

HISTORY OF MAPPING

The area was first examined in detail by the Standard Oil Co. in 1914, under permit from the Ottoman Government. It was re-examined in 1922.

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Based on reconnaissance surveys by Wellings in 1933 and 1939, the Petroleum Development (Palestine) Company obtained concessions in 1939 and mapped the area in detail on a scale 1:50,000 (1940—1941).

During 1949—1950 the entire Negev was mapped on a scale of 1:100,000 by Y. Bentor and A. Vroman with the assistance of the Israel Defence Forces. Their published map and text of the Abde Sheet No. 18 cover the southern part of the Rekhme Anticline.

Following the promulgation of the Israel Petroleum Law, its Rules and Regulations, in 1952, the Husky Oil Co. (now Israel American Oil Corp.) obtained a licence over the Rekhme Chain of Anticlines on 10th June, 1953. The Boqer Licence I/2 covered an area of 363.974 km^2 and included the North and South Rekhme, Beqqar and Insuriya anticlines. Photogeological studies were initiated in December 1953 and detailed plane table survey of the crestal area started in May, 1954.

Mapping was carried out on a scale of 1:2,000 and 1:10,000. On the basis of this work, a location was staked and a deep test spudded on 4th December, 1954. After penetrating to a depth of 2,766 m the well was abandoned as a dry hole on 14th April, 1955. The Israel American Oil Corp. relinquished its licence in June, 1956.

STRUCTURE (SURFACE)

The Rekhme chain of structures represents a general structural uplift consisting of parallel individual anticlines with general NE—SW trends and asymmetric with steep flanks to the S.E. The entire Rekhme anticline is over 60 km in length, with an areal closure of 120 km^2 and a vertical closure of 400 m. Measured dips are of the order 4° on the N.W. flank and 15° on the S.E. Of the component anticlines, the Rekhme is the largest and contains the highest structural point.

Considerable faulting is present over the structure. This falls mainly into two groups of transverse faults trending N60°E and almost due E—W. Wyssling reports the effects of transverse movements with horizontal displacement along the E—W trending faults (Figure 2). There also appears to be evidence of the asymmetric anticlines having been modified during their development by stresses resulting from these E—W faults. Folding was still active after this faulting phase as the different segments between the E—W faults display an individual and varied type of deformation.

One of the best defined and most important examples of such transverse movement in the area is noted immediately south of the crest maximum. The steep topographic cliff is in effect the result of such faulting, the uplifted block to the north having moved differentially to the east (Figure 2).

An attempt was made to determine the hade of the axial plane with depth by means of detailed cross sections over the crestal region. Constant bed thickness was assumed in attempting to evaluate this problem, as no structural thinning of beds was noted on the steep flank. The problem however is considerably complicated by the complex nature of the subsurface structure as evidenced by the results of the deep test Rekhme No. 1. It has been definitely established that the well has traversed at depth a number

of minor faults in addition to one major reverse fault (to be discussed later). The surface trace of this reverse fault is believed to be the main fault outlined above. If this is correct, the fault plane would hade approximately 83° to the North (Figure 4).

STRATIGRAPHY

The Rekhme Anticline exposes a thick section of Middle and Upper Cretaceous strata; Tertiary and Quaternary formations are restricted to the adjoining synclines.

The following description of the exposed main lithologic units has been adapted from Wyssling's columnar section. The Turonian and Cenomanian strata were measured at the crest maximum.

CAMPANIAN	6 m	Massive black flint.
SANTONIAN	35 m	White and pink chalk.
TURONIAN	23 m	Mainly chalky bedded limestone flint nodules in upper part.
	24 m	Massive crystalline limestone.
	30 m	Soft limestones and dolomites with some harder banks.
CENOMANIAN	42.5 m	Soft dolomitic and marly limestones with hard dolomitic banks.
	23.5 m	Mainly dolomitic marls.
	16 m	Dolomitic limestones, fossiliferous at base.
	36 m	Mainly soft chalks and marls, *Exogyra* beds at base.
	6 m	Hard banks of whitish limestone.
	9 m	Soft chalky and fossiliferous limestone with chalky marls at base.
	45 m	Banked, soft chalky and dolomitic limestones bearing flint nodules.
	8 m	Hard dolomitic limestones with flint horizon.
	18 m	Limestone and fossiliferous marl with *Orbitolina*.
	7 m	Massive white rudist limestone.
	37 m	Mainly marls and marly chalk, fossiliferous, ammonites near base.
	11 m	Hard dolomitic limestone, sandy *Exogyra* bed at top.

The stratigraphic boundaries in this section have been provisionally selected by Wyssling, on comparison with the author's measured columnar section in Hatsera (Figure 1).

In Hatsera, the Cenomanian-Turonian contact was placed at the base of the *Leoniceras-Thomasites* horizon. In Rekhme, Wyssling did not find these ammonites owing to talus covering and possible effects of dolomitization. The I.P.C., however, mention the presence, in Rekhme, of a certain marly ammonite zone in a similar position to that reported in Hatsera. The marly zone which is also present in Wyssling's section is therefore provisionally regarded as the Turonian-Cenomanian limit.

The Turonian-Santonian boundary has been located arbitrarily at the topmost limestone bed of the chalky limestones underlying the soft chalks. This also corres-

ponds to the contact as picked in Hatsera — the soft chalks having been found to contain *Gryphea vesicularis.*

The ammonites found near the base of the exposed section were submitted to the Geological Survey for determination. A. Parness has examined this fauna and has found *Mantelliceras vicinale* Stoliczka and *M. villei* Cog. indicative of an Upper Cenomanian (lower part) age.

A stratigraphic cross section has been prepared (Figure 3) to illustrate the correlation of surface exposures from Rekhme through Kurnub to Hatsera. These are measured sections and represent the most accurate information available on formation thicknesses.

SUBSURFACE RESULTS

The Rekhme No. 1 well was located at the foot of a morphological scarp, 12 m below the crest maximum and 270 m north to north-east of the main fault. After penetrating to a depth of 2,766 m the well was bottomed in formations of Triassic age.

The exact location of the stratigraphic boundaries traversed in the drilling is still problematical. Only two conventional cores were cut, both being located in the lower portion of the drilled section. Considerable fauna was found in the sample cuttings and was examined by M. Avnimelech and Z. Reiss of the Geological Survey.

The transition from beds of Cenomanian age to those of Lower Cretaceous age in both Kurnub and Hatsera, is a rather sharp and well defined one (passage from chalky and marly limestones to sandstone). In Rekhme we note only a gradational change — the section from below 130 m depth becoming more sandy. The Lower Cretaceous-Cenomanian contact has therefore been provisionally located at this level.

Though it is impossible to fix definitely the upper boundary of the Lower Cretaceous, a number of general remarks can be made concerning the distribution and character of the Lower Cretaceous sedimentation in the Rekhme area. Most notable is the far more shaly and calcareous nature of the Lower Cretaceous strata in Rekhme as compared to its time equivalents in both Kurnub and Hatsera. In Hatsera, two thin but distinct marine intercalations have been mapped within the 371 m Lower Cretaceous complex of variegated sands and sandstones. In Kurnub, Bentor reports the presence of three such marine intercalations in some 415 m of sandy sediments (Figure 3). The change from a predominantly continental environment type of deposition to more marine conditions of sedimentation occurs somewhere between Kurnub and Rekhme.

The first clear indication of Jurassic strata in the Rekhme boring was found in samples from 641 m. depth which contained the fauna *Kurnubia palestinensis* (Henson), *Barkerina* Sp. 21. The Lower Cretaceous-Jurassic boundary has therefore been tentatively placed at 623 m. depth, at the transition from a sandstone and sandy shale sequence to a predominantly shale and marl series (Figure 4).

Detailed analysis of the lower section of the well has indicated the exceedingly complex nature of the subsurface. Numerous faults, normal and reverse, have been found which have dissected the structure at depth into a series of blocked slivers. A major reverse fault was crossed at approximately 2,279 m and some 328 m of formational section were repeated. This has been clearly established by the duplicated section of the electric logs (Figure 5). The actual repeated interval as measured on the electric logs has been reduced to 266 m owing to the well's crossing a normal fault of about 62 m displacement at 2,456 m depth.

Good electric log correlation was found between the Rekhme and the Kurnub drillings. It is possible that sections missing in the Rekhme log as compared to the Kurnub log, are attributable to sedimentary processes. However, in view of the good electric log correlation noted between these wells and the proved existence of such faults as described above, it is believed that these intervals found to be lacking are due chiefly to normal faults. The erratic nature of the formation dips as determined by a dipmeter survey, as well as the marked deviations of the drilled hole (maximum $9^1/_4°$ with sudden return to near verticality), further substantiate the complexly faulted nature of the sub-surface (Figure 4).

In view of the above, considerable difficulty has been encountered in attempting to establish a Triassic — Jurassic contact. Most of the samples examined and found to contain Triassic fauna fall within the repeated section. It is therefore assumed that Triassic formations exist at least as high up in the well as the top of the duplicated interval, i.e. 1,910 m depth. It is quite possible, however, that the boundary may be located at approximately 1,650 m depth, where the formations become markedly gypsiferous. This would correspond to the Jurassic-Triassic boundary in the Ramon (Bentor). The last clear indication of Jurassic fauna was found at 1,457 m containing *Kurnubia palestinensis* (Henson), *Barkerina* No. 21 and *Valoubinella jurassica* (Henson). Until additional palaeontological investigations are carried out, however, the determination of stratigraphic boundaries traversed must be considered as highly tentative.

CONCLUSIONS

Though no signs of oil or gas were encountered in this well, the complex nature of the subsurface makes a critical appraisal of this drilling's significance inconclusive as to the deeper oil prospects of the area. Down to a depth of 2,279 m the well appears to have been still on structure, though slightly modified by normal faulting. Below the high angle thrust plane, however, any semblance of structural conformity to the mapped surface structure is highly hypothetical.

As has been noted earlier, the Rekhme Anticline which was tested, represents but one of many such structures in the area. Whether the Beqqar and Insuriya Anticlines simulate at depth the tectonic complexities found in Rekhme is un known.

Additional testing of these structures is required for a final evaluation of the Rekhme chain.

The nature and character of Lower Cretaceous and Jurassic sediments indicate a near shore, shallow, marine environment. The lack of any oil shows in Rekhme does not preclude the possibility of finding oil further basinwards, in equivalent time-rock units, where more suitable conditions for oil genesis may have existed. The presence of oil in Heletz, 80 km to the north-west of Rekhme, in a predominantly black shale-sandstone sequence of Lower Cretaceous age, indicates that such conditions did exist in the geological history of the region.

It is not believed that the oil accumulation in Heletz is of an isolated nature. Beyond the hinge line, marking the transition from a continental to a more marine environment, considerable interfingering of sediment occurs. Suitable stratigraphic trap conditions should abound in the form of permeability wedges, sand lenses or pinch-outs. The recognition and delineation of such features from the surface are always highly involved and complex, and often impossible. Nonetheless, it is felt that more emphasis on exploration efforts, whether surface or subsurface, should be directed to the search for such features. A clearer understanding of the nature and distribution of the sediments may provide necessary clues for successful wildcat drilling.

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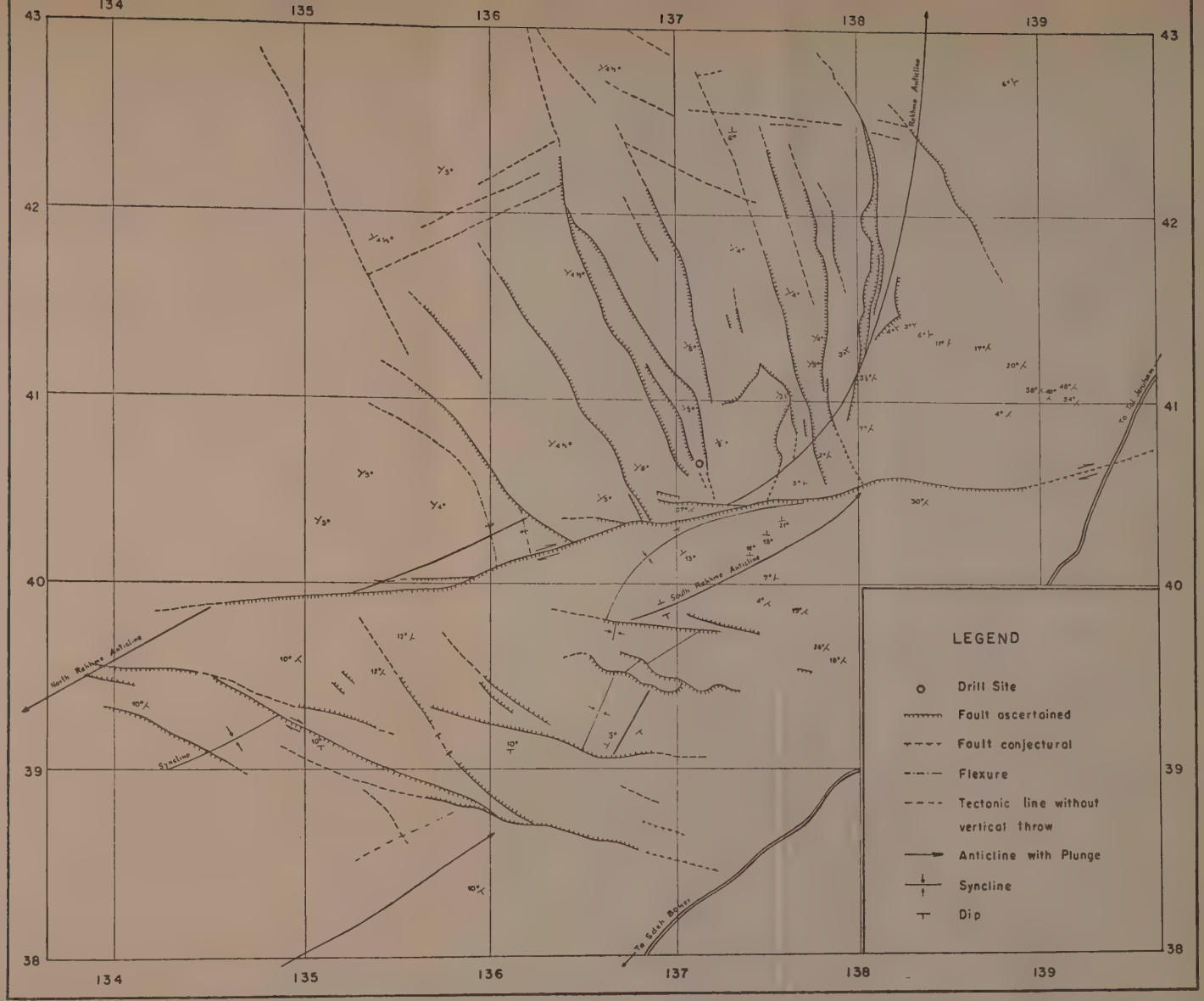
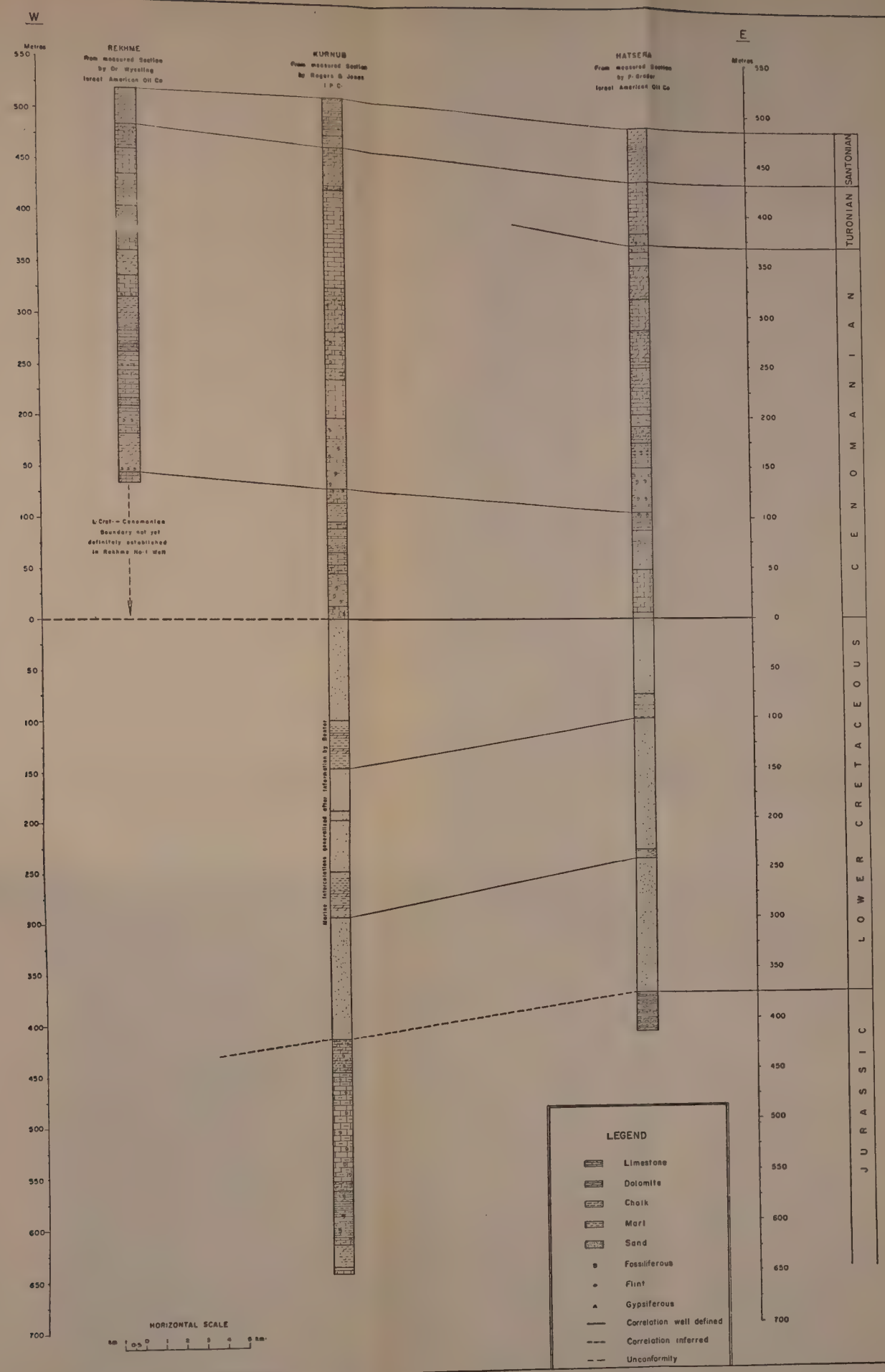


Figure 2 TECTONIC PATTERN OF THE CRESTAL AREA OF THE REKHME ANTICLINE (adapted from L. Wyssling)

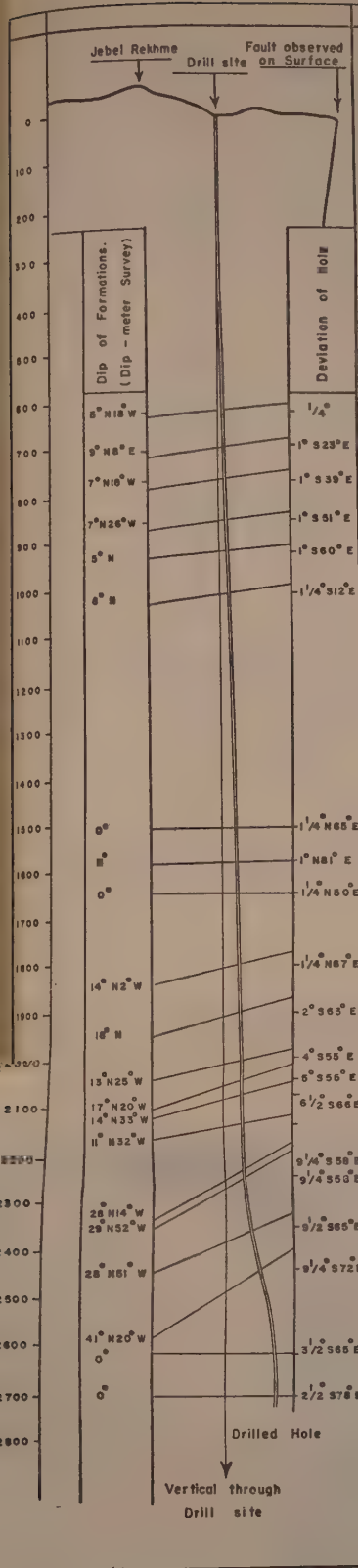


ure 3 STRATIGRAPHIC CROSS SECTION THROUGH REKHME, KURNUB, HATSERA SURFACE EXPOSURES Datum—Lower Cretaceous—Cenomanian boundary by P. Grade

Figure 4

REKHME TEST WELL No. 1.

Prepared by P. Grader Lithology after Holliger



Feet	Log	Metres	Depth	Lithology	Age	Remarks
0		0	0			
			37	Yellow dolomitic marls with hard grey dolomitic limestone bed 37-42.m	CENOMAN	
			75			
			175	Mainly limestone party dolomitic sandy and marly grey to yellow, marls sandy at base, fossiliferous.		
1000			350	Sandy shales with minor intercalations of dolomite and dolomitic limestone.	L. CRETACEOUS	
			418	Dolomite and dolomitic limestone partly marly, with some shale intercalations, lignite		
		500	475	Sandy shales dark green grey, marly and dolomitic intercalations.		
			540	Dolomitic limestone and marl, yellow to cream, intercalations of sandy shale		
2000			623	Sandstones partly cherty and sandy shales, dark grey, green, some thin lignite layers.		
			641	Black to green grey shales, pyritic limestone with thin layers of coal.	C	Kurnubia palestinensis Barkerina sp.2l (determination by Reiss)
			725	Calcareous marls and limestone, gravels at base.		
			773	Dark green grey to black shales, marly, sandy, pyritic		
3000		1000	880	Shaly and limy sandstone, grey sandy marls and intercalations of hard limestones, pyritic, oolitic and partly sandy, beige to whitish grey.	J U R A S S I	
4000			1230	Grey sandy marls, and porous limestone pyritic, sandy, partly. marly chalky.		Fault 68 m.
			1325			
			1350	Grey sandy marls, dark grey to black lignitic shales, interbedded limestone chalky, oolitic, sandy, grey-white.		Kurnubia palestinensis Barkerina sp.2l Valoubinella Jurassica
			1457			
5000		1500	1495	Grey sandy marls and sandy shales with streaks of lignite		
			1650			
			1728	Limy and dolomitic marls, gypsiferous, dolomitic limestone, sandy pyritic	?	Bottom of 9 5/8 casing
			1750	Dolomite and dolomitic limestone, marly shaly.		
6000			1805	Dolomitic marls alternating with green and grey shales gypsiferous		
			1860			
			1922			Fault 80m.
			1930			Samples 2235-2730
		2000		Multicoloured clayey shales, black grey, dolomitic - limy mudstones with thin intercalations of grey dolomite and dolomitic limestone, gypsiferous.		Beneckeia woguana Halobia diplopora Core No.1(2056-2061) Myorphoria elegans Terebratula ecki Encrinus Entalis torquata (Determination by Avnimelech)
			2056		T R I A S S I C	
7000			2101			
			2163			
			2244			
			2279	Repetition of beds from 1930-2101.m as noted on electric logs.		Reverse Fault 328.m repeated.
8000		2500	2456	Repetition on beds from 2163 - 2244.		Normal Fault Section from 2101-2163 (62m) not repeated.
			2545	Predominantly dark grey shales with intercalations of dolomitic limestone, gypsiferous.		Probably faulted
			2620			Core No. 2(2636-2641)
			2636	Limestone dolomitic. sandy, oolitic pyritic and grey dolomite with dark grey to black shales, silty, pyritiferous.		
9000			2766			
		3000		TOTAL DEPTH - 2766 m.		
10000						

D. 656. A

J. Levy

Well spudded: 4. XII. 54 Well completed: 14. IV. 55 Coords: 137125/040640 Elev.: 587.2 m.

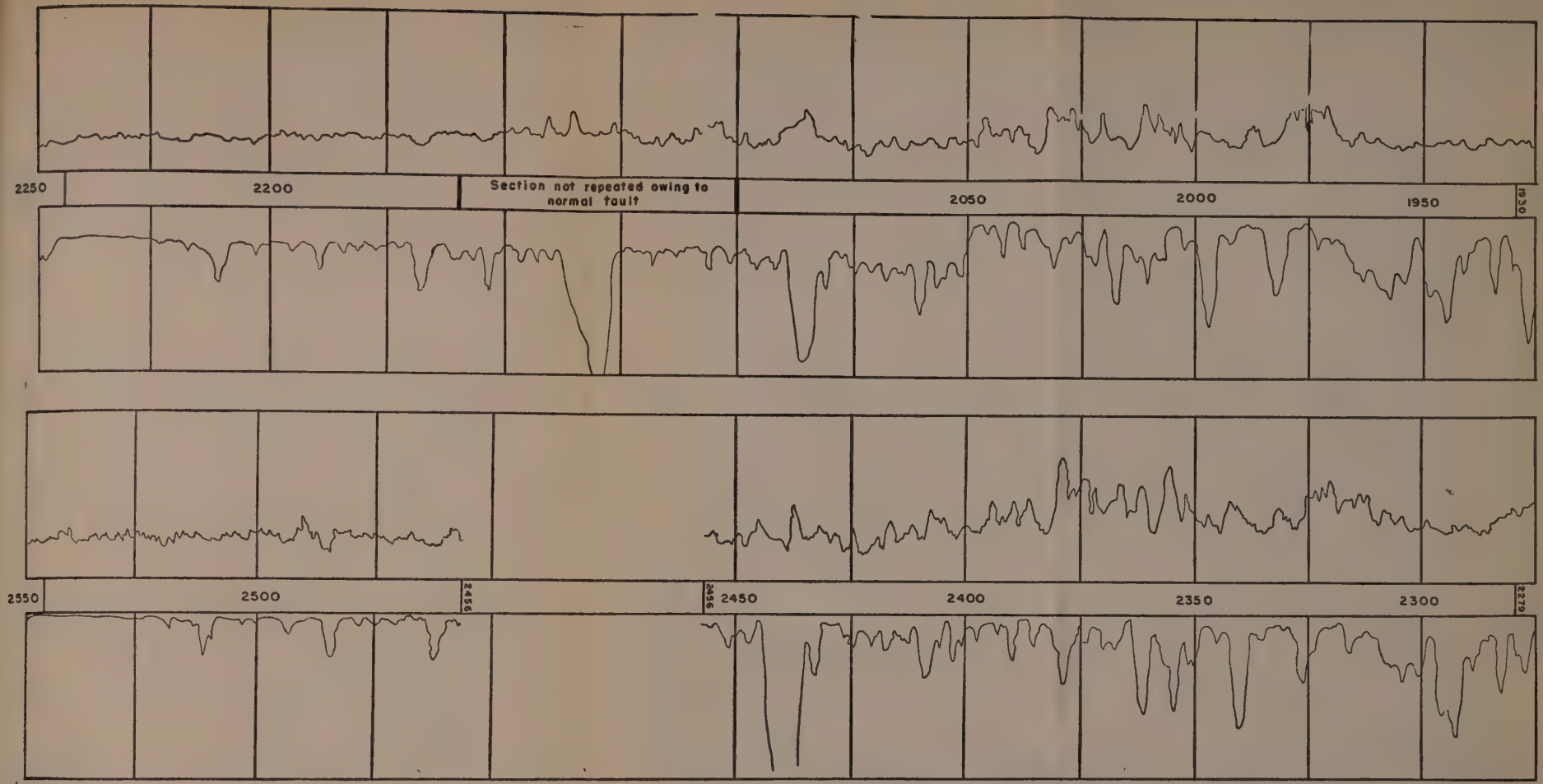


Figure 5 DUPLICATED ELECTRIC LOG SECTION OF REKHME No. 1. INDICATING REVERSE FAULT AT DEPTH

LETTERS TO THE EDITOR

Techniques for breeding the Citrus Rust Mite (Phyllocoptruta oleivora Ashm. Acarina Eriophyidae)*

In recent years the Citrus Rust Mite has become one of the severest pests of citrus groves in Israel. Its biology, however, has been unknown in Israel, and insufficiently known in the other countries where it is prevalent. The main reason for this lack of knowledge is the difficulty encountered in the breeding of this pest because of its very small size (the length of the female is about 160 μ) and the difficulty in transferring the adult and the larval stages. Furthermore, it is impossible or almost impossible to transfer the eggs; the mites are very uncomfortable in narrow restricted places, and they are sensitive to the physiological condition of the fruit or leaf.

In the course of considerable work on this pest, Yothers and Mason[1] kept the mites on picked fruits enclosed in number 0 gelatine capsules, glued with hot paraffin. As the mite can only live a short while on picked fruits, they transferred them to fresh ones, at short intervals. Leaves or branches were not used because they wilted in water. But scant results were obtained after much labour with the picked fruit technique, because in the process of transfer from one fruit to another many of the mites were lost or died. Also, the closed small gelatine capsules provided an unfavourable environment for the mites.

The technique tried here was that of wrapping fruit in "Wilt proof" and other plastic materials in order to reduce evaporation and to keep the fruit fresh. In this way the number of mites on some of the fruits increased, but this method was abandoned as the results were inconsistent.

At the suggestion of the late Dr. L. Heyman-Hershberg, leafless branches bearing lemon fruits were rooted according to the method of Erickson and De Bach[2]. The branches were soaked in a solution of hormone (Phyomone**, at a concentration of 6 cc of stock solution per $\frac{1}{2}$ litre water) for 24 hours, and the following day they were rinsed and planted in pots or sand boxes. In May the branches rooted well after about 20 days. Since fruits on leafless branches did not grow and became very hard, branches bearing both fruit and leaves were rooted. This latter method has a number of handicaps. The leaves often wilted and fell due to evaporation. To prevent this the branches had to be covered with glass bell-jars. Covering the fruit with punctured tins gave good results, but experiments to preserve the leaves by covering them with plastic materials have so far given negative results. During the winter the branches were kept in sand boxes at a temperature of 23—26°C. In order to prevent rotting of the branches, they were soaked for a short while in sand saturated with a mercurial compound before being planted in pots.

Celluloid cells, 2—3 cm in diameter, were attached to the fruit on the rooting branches. The sides of the cells slightly slanted (to facilitate observation of the mites

* Sponsored by the Citrus Marketing Board.
** Phyomone - produced by Plant Protection Ltd., England.

found beside the walls). Gelatine with addition of glycerin was used as a glue (and in cases of high humidity a fungicide was also added). Squares were drawn with India ink on the surface of the fruit in order to facilitate the localization of the eggs. The breeding was begun at the egg stage in order to avoid loss and injury of the mites during transfer. Imagines were placed in traps clear of eggs for 24 hours, after which they were removed and the eggs laid by them incubated. In order to prevent injury to the fruit, brushes were used throughout the experiment.

Leaves of young trees grown in tins, were attached by means of celluloid pinned to a table surface (without damaging the leaves). The same cells and glue were used as on the fruit. For observation purposes a binocular microscope was conveniently placed on the table over the leaves.

These methods permitted in some cases the breeding of several generations of mites on a single fruit.

Figure 1
Rooted lemon twig; arrow points to celluloid cell.

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BOOK REVIEWS

LORD ROTHSCHILD, G.M., Sc. D., F.R.S. **Fertilization.** Methuen & Co., London. 1956. 177 pp. 5 half tone plates, 30 diagrams; indexed. 18 s.

Fertilization essentially marks the onset of the development of the individual bisexual animal. It is therefore of fundamental importance to the entire field of biology, particularly that division dealing with the process of reproduction. An enormous amount of investigation of this phenomenon has been carried out, for technical reasons mostly in plants and in animals where fertilization is outside the body cavity. With advances in technology more work is being carried out in other species, including mammals, but fundamental aspects of the event are still being scrutinized in lower forms.

No student of the physiology of reproduction, however far removed his own niche for inquiry may be from the process of fertilization, is unaware of the significant work which Lord Rothschild is carrying out in this area. The announcement of a monograph by him on this subject whetted the appetites of all of us. The book is described by the publishers as follows:

"This book is about the union of a spermatozoon with an egg. The treatment is physiological, using this term in its widest sense, but considerable space is devoted to a description of what is actually seen, through the microscope, when mammalian eggs and those of lower organisms are fertilized. The biochemistry and biophysics of fertilization are discussed in detail. Chapter I deals with the morphology of fertilization; Chapters II, III and IV with sperm-egg interacting substances in the animal and plant kingdom. Chapters V and VI, on the biochemistry of eggs before and after fertilization, are followed by a comprehensive list of metabolic and other changes associated with fertilization. Other chapters deal with structural changes in eggs at fertilization (e.g., birefringence of the cortex), polyspermy, in which recent Russian work is discussed, bioelectric phenomena in eggs, and specificity. An Index of Plants and Animals, giving their Latin names, synonyms, English names, classes and orders is a welcome addition to a book by a cell physiologist. An unusual feature is a list of some experiments which have *not* yet been done. No book on fertilization has appeared for more than twenty-five years."

This is a factually correct, but understated description. The monograph vibrates with intelligent and critical appraisal of work in the field; work which has been carefully selected and culled to avoid unnecessary confusion wrought by a great amount of improperly controlled researches which are more common than should be.

In spite of the wealth of highly technical information, the monograph shows gentle and charming influence of an extremely competent guide, who knows the many pathways and pitfalls.

The closing, brief chapter, titled "conclusions", could well be called "directions", and is considered of value great enough to be included, in its entirety, in this review:

"CONCLUSION

In my preface I expressed a hope that this book would provoke further experiments. The question is, what experiments? Prophecies are always dangerous and usually wrong; but for what it is worth, I believe that the following subjects would repay further investigation:

(1) Morphology of pronuclear movements.
(2) Sub-microscopic morphology of spermatozoa in sea water and egg water.
(3) Physiology of frog's egg jelly.
(4) Turning mechanisms in plant spermatozoa.
(5) Structure-action relationships in the chemotaxis of plant spermatozoa.
(6) Variations in the receptivity of different parts of the egg surface.
(7) Oxidative carbohydrate breakdown in eggs.
(8) DNA content of eggs, spermatozoa and pronuclei.
(9) Partial fertilization, using 'cylindrical' eggs.
(10) Irritability of the *zona pellucida*.
(11) K and Na fluxes across egg surface before and after activation.
(12) Conduction velocity of capacitance change at fertilization.
(13) Membrane resistance before and after activation. This may be linked with (11).
(14) Effects of periodate and trypsin on heterologous fertilization.
(15) The morphology, physiology and biochemistry of fertilization and parthenogenetic activation *in any eggs other than those of echinoderms*. Japanese biologists have realized the importance of this subject, and in their hands it is beginning to pay dividends. Novikoff's experiments, on the escape of cortical granules from the fertilized egg of *Sabellaria alveolata*, should cause those who work exclusively on echinoderm eggs some anxiety.

Other lists could, of course, be made. The reasons, why my list contains what it does are to be found, I hope, in this book."

From an author's point of view, especially with a reference list of over 500 papers, I can sympathize with the omission of complete titles of papers in the bibliography (and publishers are probably also pleased with reduced costs, therefrom), but from a reader's position, complete listing would add to the already great value of this monograph.

The publishers' contribution of excellent typography and printing should be commended.

In summary: This is a valuable book for all biologists; essential for students of reproduction physiology.

M. C. SHELESNYAK

World Distribution of Rickettsial Diseases. 3. Tick and Mite Vectors. Plate 12, Atlas of Diseases, American Geographical Society, New York, 1954.

This plate shows very clearly the world distribution of ticks of medical and veterinary importance. Any area in which ticks of a given species have been found, is indicated by being shaded in an appropriate colour and, correspondingly, areas from which the tick under consideration has not been reported are left blank. This method of presenting the information may be quite suitable for well-studied regions like North America and South Africa, but it often becomes most misleading with respect to Asia and other points of the world where the tick fauna of many regions has not been surveyed at all. Most readers of the map will infer from the fact that a certain country is not shaded in any of the colours, that it is free from the corresponding species. In fact, the species under consideration may simply not yet have been reported from the country.

It also seems that the authors of the map who give an ample documentation from the American literature, are not so well acquainted with relevant publications which appeared outside the United States. Europe, for instance, has been quite thoroughly investigated concerning the distribution of ticks. But the map suggests that there are no Ixodid ticks in large parts of Europe (Italy, Yugoslavia, Greece, Rumania, etc.). In fact, in most of these countries ticks of various species covered by the map have been found by various authors.

(a) Schulze, P., 1925, *S. B. Ges. naturf. Fr. Berl.*, (1—10), 109; Schulze, P. and Schlottke, E., 1927/28, *S. B. naturf. Ges. Rostock*, **2,** 32; and Pantazis, G. P., 1947, *Sci. Ann. Univ. Athens*, p. 71, found *Hyalomma marginatum* K. (wrongly named *H. savignyi* in the map) and *H. excavatum* in Greece.

(b) The same species have been found in Italy, too (Koch 1844; Schulze, P. and Schlottke, E., 1927/28), and called *H. anatolicum* K. and *H. marginatum.*

(c) In Rumania, Metianu (1951, *Ann. Parasitol.*, **26,** 446) has identified *H. savignyi* (in the same sense as in the map), also found by Parvulesco (1940, *Bull. Acad. Méd. Roum.*, p. 357) and identified by Schulze as *H. marginatum balcanicum.*

Metrianu has also found *Haemaphysalis concina* in the western parts of Rumania.

(d) Oswald, 1939, *Parasitology*, **31,** 271—280, mentions *Haemaphysalis concina* from Yugoslavia.

One other example out of many others which could be cited, may be well suited to show the type of erroneous information which might be drawn from the map. According to the map, *H. marginatum* (=*H. savignyi*) occurs in the Asian-European continent only in Spain and Turkey. Actually, the distribution of this species extends throughout Southern Europe (including Italy, Rumania and large parts of Western Asia such as Southern USSR (Kazak, Caucasus, Caspian Sea) and down to Israel.

It is most regrettable that this map is so misleading because of these two shortcomings:

(a) It tends to show the progrees of the study of the tick fauna in various parts of the world rather than the actual distribution of the various species.

(b) It fails to reflect much of the up-to-date knowledge on the world distribution of many species.

B. Feldman-Muhsam

Arid Zone Research Publication no. VIII. **Human and Animal Ecology.** Unesco, Paris, 1957. 244 pp. fol.

This book combines six background papers sponsored by the Dept. of Natural Sciences of Unesco, which were to have been followed up by a symposium in 1955. Unfortunately, no funds were available in that year.

The part on Human Ecology includes two papers. It begins with a very readable pioneer essay by Regina Rochefort (Strasbourg) on the sociology of man in arid zones. W. S. Ladell (Nigeria), well known in this country from his fascinating lecture in the Desert Symposium of Jerusalem (1952), follows with an excellent review of the "Influence of environment in arid zones on the biology of man", begins with a resumé of physiological research — much furthered during World War II, but still full of lacunae — and ends with the hygiene of housing, clothing, food and living in general of man in deserts.

Animal ecology is treated in four chapters: F. S. Bodenheimer (Jerusalem) — "The ecology of mammals in arid zones", R. D. Etchecope and F. Hüe (Paris) — "Ecological studies on the avifauna of the Arabo-Saharian desert zone". The eminent locust specialist B. P. Uvarov (London) reports upon "The aridity factor in the ecology of locusts and grasshoppers of the Old World". The last review is by S. Pradhan (New Delhi) on: "The ecology of arid zone insects". Considering the backwardness of animal ecology of deserts and steppes, as compared with level of knowledge available in botany and meteorology, soil science, and microbiology, it was a splendid idea of Unesco to sponsor these background papers, which are all followed by a fair bibliography, thus being a real help to the beginning student in this field. Yet, as was agreed in the recent symposium of the Arid Zone Research Dept. of Unesco at Canberra, Australia on the Climatology of Arid Zones (October 1956), animal ecology can only hope to reach the level already gained by the just mentioned sciences, when in field stations monthly population counts for some years will be studied. It would be well in agreement with this tendency if such a field station were combined with Israel's new Institute of Arid Zone Research at Beersheba. It would be meritorious, if Unesco continued its earlier efforts by sponsoring a training course in field and laboratory methods for young students of animal ecology in arid zones. As it is, the present book represents a considerable step in the right direction. Nobody interested in this fascinating and practically important

field—either physiologist or biologist—can miss this important review. We would like to mention especially the careful preparation and the agreeable print of the publication.

F. S. Bodenheimer
Jerusalem

B. Gutenberg and C. F. Richter: **Seismicity of the Earth (and Associated Phenomena).** Princeton University Press, 1954. Second Edition.

The opinion of the reviewer of the Journal of Geology that this is "a book which the working seismologist cannot afford to miss" holds good equally for students both of general geology and of physical geology. In fact, this book might as well bear the title: Seismicity and *Structure* of the Earth, indicating the authors' constant effort to interpret the horizontal and vertical distribution plus the mechanics of earthquakes of the upper section of the globe by the major tectonic features of the crust. The book often reads like a textbook on regional tectonics, though remaining within the framework of seismologic research. Consequently, we find a bibliography which by far exceeds those given in treatises on structural geology or world tectonics.

In repeated discussions, the impressive seismic stability of the Pacific mass is dealt with. The close connection between composition and structure of the Circumpacific islands and cordilleras and the intense seismicity of these areas (80% of the earth's most important shakes) is emphasized in a masterly way. The relatively restricted number of shocks in other oceans and on the continental shields is illustrated in many figures.

Uncertainty exists, however, in the explanation of the "aseismic" as well as "seismic-minded" alpine and other strongly compressed orogenic belts. The reviewer believes that this phenomenon may be due to postorogenic fault destructions (of tertiary to recent age) of many fold ranges, e.g. of the Andes from Columbia to Chile, of Greece, of Inneranatolia, of Inneriran and to a certain extent also of the Mongolian Innerasia. The tafrogenic basin-range and bolson structures superimposed on the orogenic fold mountains of these eastern Mediterranean and Levant countries fall seismo-tectonically in our view within the Gutenberg-Richter "rift-structures". To the statement of these authors (p. 112): "great shocks occur only on major structures" we should equally apply the great seismic activity which takes place in Anatolia along the gigantic so called Paphlagonian tectonic scar.

In conformity with the great role ascribed in modern tectonic essays to the movement of basement structures, a similar trend is noted in the present book, and it has long been a subject in Gutenberg's former publications. In an impressive manner the magnitude of deep and intermediate shocks — checked to depths of 700 kilometers — is discussed. The authors have shown the remarkable zonal arrangement of deep, intermediate and shallow earth quakes from east to west to the Andes. This coincides

well with the evolutionary picture from the Brazilian shield to the Pacific coast given by this reviewer in 1948 (*Bull. Soc. Géol. France*, p. 804—5).

It is, finally, hoped that recent writers on regional seismology adopt Gutenberg-Richter's method to base earthquake classifications mainly on instrumental data (a,b,c,d) and avoid the Mercalli and other scales. We agree whole heartedly with Gutenberg and Richter's introductory remark: "Gross errors have occurred when concentration of population or works on construction in a small part of a shaken region has given an erroneous idea of the distribution of seismic intensity".

L. PICARD

A. I. METSON. **Methods of Chemical Analysis for Soil Survey Samples.** Soil Bureau, New Zealand Department of Scientific and Industrial Research. 1956. 208 pp. £ 1-10-0.

Soil samples are submitted for chemical analysis for a variety of reasons. In the present volume, the author, who is Chief Chemist of the New Zealand Soil Bureau, presents the chemical methods in regular use for the examination of samples in conjunction with soil surveys and for the general characterization of the fertility status of soils. In New Zealand, the following analyses are normally performed on a routine basis: *p*H, organic carbon and total nitrogen, citric soluble phosphorus, cation exchange capacity and exchangeable cations (Ca, Mg, K, and Na), carbonates in calcareous soils, and total soluble salts in saline soils. The analytical methods are given in detail, preceded by a general statement of the purpose for which each determination is made and with an indication of the information that can be obtained from the results. An appendix summarizes the interpretation of the analyses as applied to New Zealand soils.

In addition, methods for analyses only occasionally performed are included. These are: total phosphorus and sulphur, nitrate and ammonia nitrogen, exchangeable manganese, analysis of plant litter and compost, and the soluble constituents of the water extract of soils.

The manual reflects extremely well the most recent developments in soil analysis, with regard to both techniques and choice of determinations. The subject matter is presented in a clear and systematic way, and should prove extremely useful to many workers in smaller laboratories. The text is documented by numerous references, totalling some 500 in all, practically all from English language journals.

The limits of accuracy of the determinations are discussed only in connection with the cation exchange analyses, yet it is gratifying to note that the author recognizes the fallacy of reporting too many significant figures, a practice which unfortunately is not lacking in soil literature.

Although the book is primarily intended to serve as a laboratory manual, a great deal of general information related to the subject matter is assembled in the intro-

duction to each chapter. The discussion of cation exchange properties is the most extensive and also the most valuable. The significance here attached to the total cation exchange analysis characterizes well the increased attention being paid to the interpretation of soil data. When judged in conjunction with field morphological observations, no other chemical characteristic is capable of supplying so much information about the pedogenetic aspects and about the potential productivity of a soil. Modern analytical techniques, employing flame photometers for Na and K, and versenate titration for Ca and Mg, have made routine determinations of cation exchange properties possible on a considerably increased scale.

The author is well aware that future developments in techniques may make other methods equally common, particularly with regard to the identification and estimation of the constituent clay minerals and of the organic components of a soil. At the same time, it may be regretted that he has not found it necessary to include some additional methods, also specific for soils and often used in the characterization of soil types, such as the determination of free iron and aluminium oxides.

DAN H. YAALON

PROCEEDINGS
OF THE
SECOND CONVENTION
OF
SCIENTIFIC SOCIETIES

Jerusalem, July 14—17, 1957

CONTENTS

THE ISRAEL SOCIETY OF SOIL SCIENCE

Session A (Tuesday morning)

Chairman S. RAVIKOVITCH

Unsaturated unsteady flow of water through soils

S. IRMAY, *Technion—Israel Institute of Technology, Haifa*

Darcy law $q = -k\,\mathrm{grad}E$, proved to be valid in steady flow of water with interspersed gas-bubbles, gives the hydraulic conductivity k varying as $(c-c_0)^3$ (c = moisture concentration). Defining the energy $E = z + \int dp/(c-c_0)$, Darcy law is extended to unsteady flow, neglecting capillary effects. A non-linear second-order partial differential equation is obtained, similar to the Ollendorf-Irmay equation of gravitational diffusion, but with diffusivity D variable with c: zero at air-dry moisture $(c = c_0)$, infinite at saturation.

In linear horizontal flow c depends on $(x-x_0)/t^{\frac{1}{2}}$ alone (x = abscissa, t = time), as verified experimentally. This is valid initially in any direction. In descending flow there is an asymptotic solution c function of $(x - At)$ alone.

In plane horizontal flow a potential may be defined, not so in three dimensions.

Capillary effects are investigated.

Weathering of soft calcareous rock*

M. BEN-YAIR, *Standards Institute of Israel, Tel Aviv*

Physico-chemical studies of the soft calcareous rock of the mountain regions of Israel are described.

Weathering takes place in the following stages: In winter, rain-water penetrates into the soft calcareous rock, replacing the air in the rock with a water reservoir which expands the rock. In summer, the water evaporates as it rises towards the upper layer of the rocks, and the rock shrinks. All through this process, the calcium carbonate content is preserved in the water reservoir in winter, and in the upper layer of the rock in summer.

With the repeated weathering of the rock in this way, its surface gradually disintegrates, forming the grey-white calcareous soil.

* Part of a P.D. thesis carried out under the guidance of Prof. hS. Ravikovitch.

Soil moisture availability in loess soils

Y. Rubin, Y. Putter, H. Bielorai and D. Shimshi, *Agricultural Research Station, Rehovot*

Moisture availability in a given soil may be conveniently described with the aid of the following three soil characteristics:

(1) field capacity, which is generally considered to be the upper limit of the available soil moisture;
(2) permanent wilting point, which is usually believed to be the lower limit of this moisture;
(3) soil moisture content, which is critical as far as growth (or yield) of a given plant is concerned.

The nature of the first two characteristics is more or less understood and the methods of their measurement are well known. The third characteristic is less understood and may be tentatively defined as the water content level above which the root zone moisture must be kept if plant growth (or yield) is not to be seriously impaired.

A method for determining critical moisture content in the field is described. Distinction is drawn between apparent and real critical moisture content, and a method for determining the latter in the greenhouse is described.

Results of using the above techniques in connection with irrigation of corn, wheat, peanut, sugar beet and potato crops in the Northern Negev loess are demonstrated, and the following conclusions drawn:

(1) The apparent critical moisture of a portion of the root zone of a given depth (e.g. 0—60 cm soil layer) had a certain characteristic value for each crop studied. There existed a clear correlation between this critical moisture value and the root zone depth.
(2) The apparent critical soil moisture of root zone from which the crop withdrew about 75% of its seasonal water requirement was equal for all crops studied, except for the sugar beets. This critical moisture was also equal to the true critical moisture content as determined in the greenhouse with the aid of sunflowers.
(3) For sugar beets, the moisture content of the above mentioned layer apparently critical to growth (as measured by fresh weights of beets) was equal to the apparent critical moistures of the same layer in all the other crops studied. On the other hand, the moisture content apparently critical to sugar yield was considerably lower.

The influence of various soils on the mineral composition of banana leaves

N. Bidner-BarHava and S. Ravikovitch, *Agricultural Research Station, Rehovot*

Banana plants grown on the calcareous soils of the Jordan Valley are in most cases poor in suitable shoots so that the plantation has to be discarded after two

or three crops, whereas plantations of the coastal region have a life period of 4—6 years, and at times as long as 10—20 years.

Excess of lime in these soils was suspected to retard the normal development of shoots by inhibiting the absorption of nutrients required by the plant.

Samples of leaves for analysis were collected from mature fruit-bearing banana plants and from shoots of normal banana plantations, typical of their region, and of the same age. Chemical analyses showed that the foliar mineral content of shoots of bananas growing in calcareous soils differed widely from that of bananas growing in alluvial soils of low and medium lime content, or in red-brown sandy soils lacking lime or of a very low lime content. The former, in comparison with the latter, contained more calcium, more magnesium, less potassium, and had a higher ash content. The (Ca + Mg):K ratio, expressed on an equivalent basis, in the banana leaves of the calcareous soils was 3 times and 2.5 times as high as that of sandy and alluvial soils, respectively.

The higher calcium and magnesium content and the lower potassium content in the leaves of shoots of bananas grown on calcareous soils indicate a disturbance in the normal nutrient balance in the plant, which apparently interferes with the development of vigorous shoots. Thus the plantations must be discontinued after a short period.

The problem will be further investigated with the object of finding a way to improve the required nutrient balance in the banana plant growing on calcareous soils with a consequent life prolongation of the plantation.

The utilization of sewage effluents for agricultural purposes in European countries (travel notes)

E. Muravsky, *Agricultural Research Station, Rehovot*

Session B (Tuesday morning)

Chairman S. Irmay

Hindering effect of barium chloride and calcium sulphate on selenium absorption by alfalfa

S. Ravikovitch and M. Margolin, *Agricultural Research Station, Rehovot*

The existence in Israel of seleniferous soils producing forage of high selenium content considered dangerous to livestock fed on it, has raised the problem of finding a way to interfere with the excessive uptake of this element by the plant. For this purpose soil treatments based on the principles of ion antagonism and fixation of selenium in an insoluble form were carried out.

Monocalcium phosphate, calcium sulphate and barium chloride were supplied to soils containing 4.0 and 0.5 ppm of Se, in order to determine their inhibitory effect on the uptake of selenium by alfalfa, used as a test crop in a greenhouse experiment.

The monocalcium phosphate had a very limited inhibitory effect.

The addition of gypsum as an antagonistic amendment to the soils caused a significant reduction in the selenium uptake by the plant. However, quantities required were considerable.

The hindering effectiveness of barium chloride on selenium absorption by the plant, even when added in small quantities, was exceptionally pronounced; in soil of lower selenium content, it stopped the absorption completely. $BaCl_2$ fixes the soil selenium in an insoluble form, not available to the plant.

Barium was not detected in the plants grown on the $BaCl_2$-treated soils.

The application of barium chloride may be suggested as an effective method to hinder selenium uptake by alfalfa from seleniferous soils.

The use of yield curves for the comparison of fertilizers

J. HAGIN, *Faculty of Agriculture, The Hebrew University, Rehovot*

Superphosphate was applied to soil in four portions, both in powdered and in granulated form. Curves were calculated relating the yield to the various amounts of phosphate applied. The slope of the curves expressed by the "*Factor c*" in the Mitscherlich equation serves as a yardstick for comparing the efficiency of the different forms in which the fertilizer is given.

The preliminary condition for this procedure is the comparison of the maximum yield value possible under the given conditions. After having obtained the curves relating to the yield, the value of available phosphorus in the soils is introduced by means of regression calculations.

Phosphorus tests of the plants showed that, under the conditions of our experiment, limiting factors existed as regards the different phosphorus levels.

From the experiment it was concluded that, as far as the reaction of the plant is concerned, it does not make much difference whether phosphorus is applied in powdered or in granulated form. However, it should be borne in mind that no practical conclusions can be drawn from experiments conducted in pots, for different agrotechnical conditions prevailing in the field are liable to exert considerable influence.

The formation of brown-red sandy soils from shifting sands along the Mediterranean coast of Israel

S. RAVIKOVITCH AND B. RAMATI, *Agricultural Research Station, Rehovot*

Various views have been expressed on possible modes of formation of the brown-red sandy soils along the Mediterranean coast.

In a previous investigation on the agricultural utilization of shifting sands, the

changes that took place in these sands with the growth of vegetation under irrigation were pointed out. These changes were reflected in the rise of organic matter, increase of finer fractions, aggregation of the sand and the development of a large microbial population. With these changes the original shifting sands have gradually approached in their properties those of the lighter types of the regional brown-red sandy soils.

Additional investigation has revealed that certain changes occurred also on the surface of the grains. Microscopic examinations of the sands in the experimental plots showed a gradual accumulation of a colloidal brown-red coating on the surface of the grains, similar to that found on the grains of brown-red sandy soils. This coating has changed the natural colour of the sands to brown-red.

It was also found that the molecular ratio of SiO_2: $(Fe_2O_3 + Al_2O_3)$ in the colloidal coating of the sand was nearly equal to that found in the brown-red sandy soils.

From the results of these investigations it seems that the brown-red sandy soils of the coastal plain could have been formed from the shifting sands, with the vegetation taking an active part.

Design of border checks and their comparison with sprinkler irrigation

E. Rawitz, D. Shimshi and Y. Rubin, *Agricultural Research Station, Rehovot*

When planning new irrigation areas, an evaluation of several possible irrigation methods must be made. This evaluation must consider (a) the adaptability of each method to the crops to be grown based on quantity and quality of yields obtainable, (b) the performance of each method under the particular physical conditions (water application efficiency, uniformity of water distribution), (c) economic factors.

In a proper comparison, all methods must operate under optimal conditions. For this experiment, conducted at the Gilat Experimental Farm in the loess region of the Northern Negev, the optimal design for border checks had to be previously determined, since this was the first time that border checks were constructed in this region. It was found that on these soils, very good performance could be obtained with border checks. Furthermore, these favourable results were obtained with much smaller irrigation heads than are usually necessary on other soils. An exception to this are perfectly flat checks, where the required head is not appreciably smaller.

Comparing border check flooding with sprinkling, it was found during two-and a-half growing seasons (with Sudan grass as crop in summer 1955, alfalfa from spring 1956 to date) that there were no differences in yields obtained with either methods, but that with border checks, higher water application efficiencies were attained.

On the use of meteorological data in the determination of the probability of success of supplementary irrigation

S. Gairon, D. Shimshi, Y. Putter and Y. Rubin, *Agricultural Research Station, Rehovot*

It is shown by means of meteorological indices that the annual fluctuations in monthly evapotranspiration rates are relatively small as compared to fluctuations in rainfall. It is therefore possible to use experimental data on evapotranspiration, stemming from irrigation experiments carried out over a number of years, for the purpose of predicting evapotranspiration rates during any year.

A method is thus introduced by means of which it is possible, through analysis of meteorological data, in conjunction with fundamental soil and plant data obtained from irrigation experiments (critical soil moisture, daily yield decrease due to soil moisture below critical level, depth of main root zone), to estimate the soil moisture of the main root zone at any time during the season when soil moisture is being replenished by scheduled irrigations and by (observed) rainfall.

The relative success of an irrigation schedule for a given year and location is determined by the following factors: (a) the number of days during which the soil moisture in the main root zone was below critical level, and (b) the amount of water lost by wrong amount and timing of irrigation water applied. The ratio between the number of years during which a certain irrigation schedule is "successful" (e.g. resulting in yields equal to or exceeding 80% of maximum obtainable yield, and avoidable water loss less than 20%) and the total number of test years, was an index of the probability of success of a given schedule for a particular locality.

The use of the above method is demonstrated as applied to estimating the probability of success of supplementary irrigation of wheat at several locations in the Negev, on the basis of irrigation experiment results obtained at the Gilat Experimental Farm. This method can be of use to farmers, irrigation engineers, and settlement authority planners in the solution of problems involved in the efficient use of irrigation water during the rainy season.

Session C (Tuesday afternoon)

Chairman Y. Rubin

The effect of water stress on the cell wall metabolism of plant tissue

L. Ordin, *Agricultural Research Station, Rehovot*

The sensitivity of plant growth to water stress is one of the central problems of irrigated agriculture. Recently it has been shown that one of the primary reactions

in growth of the *Avena* coleoptile is a plasticization of the cell wall and that synthesis of cellulose is a prerequisite for the continuation of the growth process. Short period experiments were carried out with carbon 14 in order to study the effect of osmotic pressure on the metabolism of the cell wall. It was found that incorporation of uniformly labelled C^{14} glucose into protopectin and into cellulose is markedly depressed by increased osmotic pressure, whereas incorporation into non-cellulosic polysaccharides and into polyuronide hemicelluloses is less affected. Pectin radioactivity, on the other hand, tends to increase as osmotic pressure rises before decreasing at higher water stresses. The question of the relative sensitivities of protopectin and of cellulose metabolism to water stress will be discussed.

Chemical composition of the desert soils in Central and Southern Negev

F. Pines, *Agricultural Research Station, Rehovot*

The purpose of this investigation was to study the composition of soils in the arid region of the Negev, and to ascertain their possible use for agricultural purposes.

The soils of the Central and Southern Negev were classified in six main groups: loess and loess-like soils, hammadas, desert coarse alluvium, sandy soils, saline hydromorphic soils (sebhas), and brown and grey hilly desert soils.

By their texture the loess soils belong to loams and silty loams, the loess-like soils belong to sandy loams. The hammadas are composed of a mixture of loam and gravel. The desert coarse alluvium is composed primarily of stones of various sizes and small quantities of sandy soil and loam. The texture of the hydromorphic soils is from clay-loam to sandy loam, and that of the desert hilly soils is loam and clay-loam, both mixed with gravel,

All soils contain calcium carbonate, mostly from 10 to 80 %. The *p*H of most of these soils lies between 7.0 and 8.6. Most soils, with the exception of the sandy soils, are saline. The salts are composed mainly of chlorides of sodium, calcium, and magnesium, and also of gypsum.

All soils are poor in organic matter and nitrogen. Only in certain places of the sebhas, an appreciable quantity of organic matter was found. All soils are rich in phosphorus and some are also rich in potassium.

Of the exchangeable cations, exchangeable sodium occupies a notable place.

The microbial population in the loess and loess-like soils is sufficiently developed, but in the hammadas it is in a state of poor development.

Most soils that are, as far as their texture and depth are concerned, suitable for cultivation, would need an ameliorating treatment by washing out their excess soluble salts. In some cases the lowering of the ground water level would be necessary.

The availability of calcium and calcium-potassium-iron relationship in plants grown in calcareous soils

Y. Noy, *Water Authority, Ministry of Agriculture*

Calcium availability in calcareous soils was investigated by the Neubauer technique. Radioactive calcium salts, one soluble (acetate) and the other insoluble (carbonate), were added to soils. The uptake of calcium by grasses from the added soluble source indicated limited availability of native calcium. There was some uptake from the added calcium carbonate.

The relative uptake of calcium by grasses from five calcareous soils was investigated. The correlation between available calcium and exchangeable calcium in the soil was confirmed. The available potassium in the soil was suggested as being decisive in determining the uptake of calcium and the K/Ca ratio in the plant tops.

The calcium, potassium and iron contents of grasses grown in calcareous soils were determined and the changes in their relationship after iron salts were applied to the soil, or sprayed on the plant, followed. Iron increased in the tops of the plants after the iron applications. Potassium and calcium percentages generally decreased. The K/Ca relationship in the plants did not change in a consistent manner for all soils. The changes were shown to be physiological phenomena. Iron applications did not affect calcium availability in the soil.

Processing of peat from the Hula valley and the agricultural value of the product*

K. Schallinger, *Agricultural Research Station, Rehovot*

The Hula peat contains a high percentage of organic matter (50—80%) and nitrogen (1.5—2.5%). The stable character of the organic compounds in the raw peat limits its effectiveness both as plant nutrient and as soil ameliorating agent. Those compounds were activated by various treatments. The use of anhydrous ammonia under different conditions was one of the methods.

For determining the fertilizing value of three differently processed peat samples, each containing about 4% total nitrogen, greenhouse experiments were performed. The processing methods were simple — without resorting to external heat and additional pressure. The experiments were carried out on two soil types, sandy loam and alluvial soil, amended with the processed peat and growing different crops in rotation. The effectiveness of the processed peat was compared to that of ammonium sulphate, stable manure, blood meal and raw peat added at three different rates.

The soils to which processed peat was added produced yields equal to those obtained from soil fertilized with ammonium sulphate (the standard fertilizer) and significantly higher than the yields obtained from soil amended with raw peat.

* Joint research with S. Ravikovitch.

Filtration of industrial sewage water for irrigation

S. POPPER, *Water Authority, Tsemah*

Israel has only 50% of the irrigation water needed for intensive agriculture. Therefore, every step has to be taken to recover the sewage water from industries for purposes of irrigation.

In industrial sewage waters, there are many harmful substances which must be eliminated. Several filtrations may be necessary to change the harmful substances into harmless chemical compounds.

I. (1) *Elimination of acids*: To eliminate the acids the use of limestone is proposed according to the following:

$$2HCl + CaCO_3 = CaCl_2 + H_2O + CO_2$$
$$H_2SO_4 + CaCO_3 = CaSO_4 + H_2O + CO_2$$
$$2CH_3COOH + CaCO_3 = Ca(CH_3COO)_2 + H_2O + CO_2$$

(2) *Elimination of alkalis*: To eliminate the alkalis the use of copper is recommended according to the following:

$$2\ NaOH + Cu = Cu(OH)_2 + 2Na$$
$$Na_2CO_3 + Cu = CuCO_3 + 2Na$$
$$Na_2S + Cu = CuS + 2Na$$

The sodium ions combine with the water and again bind the copper.

(3) In assistance to copper, gypsum may also be used. It is slightly soluble in water and acts as follows:

$$Na_2CO_3 + CaSO_4 = Na_2SO_4 + CaCO_3.$$

(4) Charcoal helps as an adsorber for most organic substances and other unwanted substances found in industrial sewage water, as for example cyanide (CN).

(5) Zif-zif (sea sand) is a fine filtering material.

(6) Big stones on the bottom of the filter are helpful for filtering the converted insoluble colloidal substances, produced in the various chemical reactions.

II. Descriptions are given of various industries in Israel as regards the sewage water they produce: e.g. leather tanning and dressing, textile dyeing, sugar, petroleum distillation and refining, vegetable oil, metal, etc. The factories must be responsible for proper treatment of their sewage effluents to make the water suitable for irrigation purposes.

Session D (Tuesday afternoon)

Chairman N. BIDNER-BARHAVA

Soils of the Southern Negev and Sinai

Y. DAN, *Agricultural Research Station, Rehovot*

Sinai and the Negev are mostly extremely arid. Most of the soils were formed by physical disintegration of rocks or by transport of erosion products from their place of formation. The small extent of chemical weathering which is seen mostly in soils that were formed *in situ* is influenced by the action of soluble salts.

Seven groups of soils were identified. Of these, three were formed *in situ* and four other groups bear evidence to the fact that the action of water and wind is responsible for their formation.

(1) *The Hammadas* were formed from various parent materials, mostly calcareous, under conditions of extreme drought. They were overlain with a characteristic cover produced during the erosion process. Here we witness a definite chemical weathering. These soils are flat, silty and salted. They have a definite characteristic profile. We can differentiate between types of Hammada that were formed from marine sediments and those that have originated in terrestrial deposits of cobbles and gravel.

(2) *Desert calcareous soils* were partly formed from soft calcareous rocks under extreme arid conditions and partly from various calcareous rocks in the more humid regions of the Negev. These soils are silty, saline, and contain large quantities of calcium carbonate.

(3) *Desert soils poor in calcium carbonate content* were formed from various magmatic rocks, principally porphyritic, prevalent in southern Sinai. They are mostly silty but some are of sandy type. Their calcium carbonate content is small, 2—15 percent.

(4) *Desert coarse alluvium soils* were products of eroded stones and gravel deposited at the foothills, in the alluvial fans, at the Wadi beds and other places. The size of the stones and the texture vary with the distance from the hills.

(5) *Sandy soils* are found in various parts of the Negev and Sinai. Among these soils, different types exist depending on the origin of the sand (aeolian or fluviatile).

(6) *Loess and loess like soils* were developed from deposits of fine fractions partly transported by the wind and deposited on the hills that were swept down to the valleys (aeolian-fluviatile loess). In the extremely arid parts, areas are found to which the loess material was transported from nearby by flood water. This alluvial product varies in its composition depending on the type of rocks found in the vicinity. Consequently soils poor or rich in calcium carbonate are found.

(7) *Hydromorphic saline soils* were formed in places where the ground water table is close to the surface. The soils are saline, especially in the upper layers, where the soluble salts reach a high of 50% and more. Most of these soils have originated from fine alluvium and sand and some from other parent material.

The influence of various cultivation methods in agricultural experimental groves on absorbability and other qualities

D. CARMELI, *Ministry of Agriculture, Haifa*

Soils of the Kishon valley

S. RAVIKOVITCH, H. KOYUMDJISKY AND Y. DAN, *Agricultural Research Station, Rehovot*

A detailed soil map of the Kishon valley (area 307.000 dunam — scale 1:20.000) was prepared.

The soils of the Kishon valley originated mostly from erosion products transported from the surrounding mountains. On the hills lining the valley, and to some extent in the valley itself, residual soils are found. Among the soils developed from the eroded materials one can distinguish: colluvial soils situated at the foothills and resembling in their characteristics the residual soils, and alluvial soils situated in the valley plains and whose properties differ from those of the original residual soils. In some areas of the valley, especially in its western parts, hydromorphic soils are also found.

The soils of the valley are subdivided in the following manner:

Residual (Primary) soils

(1) Mediterranean Red Earths
   (a) Terra rossa — formed from hard limestone or dolomite: these are brownish-red heavy clay soils of a granular to nutty structure; mostly non-calcareous.
   (b) Basalt soils: brown heavy clay soils of a blocky or prismatic structure; mostly non-calcareous.

(2) Rendzinas
   (a) Formed from hard chalk: brown heavy clay soils of a granular to nutty structure.
   (b) Formed from soft chalk and marl: brownish grey and grey clay loam and loam soils, of an unstable crumb structure; highly calcareous.

Colluvial soils

(1) Colluvium derived from Mediterranean Red Earths: stony clay soils situated on foothills; often non-calcareous.

(2) Colluvium derived from hard chalk rendzina or from a mixture of rendzina and terra rossa: stony clay soil mostly found in saddles and on foothills; of a granular structure; calcareous.

Alluvial soils

(1) Brown alluvial soils derived from Mediterranean red earths:
Heavy clay soil of blocky or cloddy structure; mostly calcareous; this soil type is the most widespread in the valley.

(2) Brownish-black alluvial soils derived from hard chalk rendzina:
Heavy clay soils, of a blocky or cloddy structure; calcareous; found primarily in the northern part of the valley.

(3) Brownish-grey mixed alluvium derived from soft chalk and marl rendzinas, and Mediterranean red earths:
Calcareous clay soils found to a limited extent.

Hydromorphic soils

(1) Grey swamp soils:
Heavy clay soils of a prismatic structure; calcareous and in some cases saline; found to a limited extent.

(2) Grey-brown hydromorphic soils:
Heavy clay soils, calcareous and sometimes saline. Ground water table at a depth of 2—4 m; very common in the western part of the valley.

(3) Grey hydromorphic soils:
Clay loam and clay soils, highly calcareous. Ground water table at a depth of 2—4 m. Because of the high lime content the drainage of these soils is better than in the other hydromorphic soils.

(4) Brown hydromorphic soils:
Heavy clay soils, poor or lacking in lime. Ground water table at a depth of 2—4 m.

Pedological investigations in connection with soil salinity in the south-western part of the Kishon valley

N. Buras, *Water Planning for Israel*

The Kishon valley soils are fine-textured and have low permeability. The natural slope is about 1%, and in many instances there is no outlet for the surface runoff towards natural or artificial drainage ways. In many places, high water tables continuously supply the upper soil horizons with moisture. Therefore drainage works in the Kishon valley must lower water tables and improve soil properties connected with the moisture regime.

Plans for the construction of drainage works in the Kishon valley were made on the basis of pedological and hydrological investigations carried out in an area of approximately 4,000 dunams in the south-western part of the valley.

96 soil samples from different depths were analysed. The electrical conductivity of the saturation extract was determined in order to establish the area and depth of saline soils.

Correlation was sought between the saline soil and the ground water. One ground water map was plotted showing the relative depth of water at the beginning of December 1956 (before the rains started), during which the lowest point was reached by ground water during the current hydrological year. Even at its lowest ebb, the ground water is found in certain places within the upper 2.0 m of soil profile. In none of these places were saline soils detected. A second map showing the relative depth of water table at the end of March 1957 (end of rainy season) was plotted showing the maximum rise of ground water during the same year.

When water tables reached their highest elevation, there were still many places where the top 2.0 m of soil were not affected. Some of the saline soils were found exactly in such places. Apparently the mere presence of ground water is no cause for soil salinity. It is possible that where water table is permanently high and soil salinity is within tolerant limits (electrical conductivity of saturation extract less than 4.0 mmho/cm), there are conditions such that the concentration of soluble salts is constant, or it changes yearly only slightly, under the influence of natural precipitation (annual average 570 mm).

Ten of the thirteen saline soil samples were found to be located exactly in the area where ground water was saline, and at a depth (60—200 cm) close to the water table. It is inferred that the soil salinity is caused, in this case, by saline ground water penetrating the area.

Of the other three saline samples two belong to an alluvial soil type lacking carbonates. It is possible that other soil forming factors contributed to the high percentage of soluble salts. Data available on the third saline sample were insufficient to offer an explanation.

The practical application of the foregoing discussion is to discontinue the process of soil salinization by intercepting the underground flow of saline water by means of open ditches, tile or discharging wells.

The mineralogy of limestone derived soils

DAN H. YAALON, *The Hebrew University of Jerusalem*

The mineralogical composition of the insoluble residues from limestones and marls in Israel and England has been determined and compared with that of the overlying soils.

The characteristic clay minerals of limestone residues in Israel are palygorskite and montmorillonite. These are being inherited by the soils, and exert an influence on the pedogenic process. The less stable palygorskite weathers as decalcification advances, and in the more leached terra rossa soils montmorillonite is the dominant clay mineral. There appears to be little alteration of clay minerals as long as the soils remain calcareous.

Under more intensive weathering conditions, as for example on the leached brown soils in England, soil processes may have completely modified the clay mineralogical

composition. The proof that the soil has been derived from the underlying chalk rests in such circumstances on the mineralogy and particle size distribution of the non-clay fractions.

Irrigation experiments with hybrid corn

H. Bielorai, Y. Rubin, A. Mantel and S. Feldman, *Agricultural Research Station, Rehovot*

One of the most urgent problems of Israel agriculture is the determination of the optimal irrigation frequency and the corresponding single-application magnitude for various field and track crops.

Methods are described for the determination of the irrigation requirement as they were applied to corn irrigation experiments at the Gilat Experimental Farm in the Northern Negev, and at the Neveh Ya'ar Experimental Farm in the Yizre'el valley.

Experiments were carried out on the influence of irrigation frequency on grain yield per dunam, the influence of irrigation frequency on water withdrawal extraction rate, the relation between seasonal water application and grain yield per dunam, the relation between seasonal water application and grain yield per unit of water, and on the influence of production cost and market price of corn on the economically optimal seasonal water application.

The results of these experiments indicate that, in order to obtain maximum yields, it was necessary to supply about 430 mm of water to cover evapotranspiration, plus another 110—230 mm to cover water losses during irrigation. It appears that this amount of water should best be applied in five to six irrigations, with a resulting single irrigation size of 85—100 mm. Comparison of these practical results obtained in the Negev with those from Neveh Ya'ar in the Yizre'el valley, shows that the irrigation requirement of hybrid corn is rather similar in both locations, although there were large differences in yield when only a few irrigations were given.

More fundamental results include determination of the apparent critical moisture, as expressed by soil moisture tension (this index makes possible extrapolation of local results to a larger region within the area of the same soil type). The influence of the soil moisture regime on plant development, determination of irrigation need by means of physiological indicators, and the development of the root system during the growing season, will also be discussed.

Supplementary irrigation in the Northern Negev

D. Shimshi and S. Gairon, *Agricultural Research Station, Rehovot*

In the Northern Negev, profitable yields of winter grains cannot usually be obtained without supplementary irrigation, since rainfall is scarce (about 250 mm. yearly) and its fluctuations are large.

A series of experiments was conducted at the Gilat Experimental Farm in the ears 1954—55 and 1955—56 in order to examine the response of wheat to supplementary irrigation. The first year turned out to be unusually dry and the second uite wet. In spite of the marked difference in the irrigation requirements between he two years resulting from the difference in rainfall, there was good agreement n the total water requirement.

Plots received a different number of irrigations: one with no irrigation, and thers with one, two, three and five water applications.

In the dry year three irrigations were required to obtain maximum yields; only ne irrigation was required in the rainy year.

The critical moisture level of the root zone, below which wheat shows reduction f yield, was determined. A linear relationship was found between yield reduction nd the duration of period during which the root zone was below the critical moisture, ut above the permanent wilting point. Below PWP the damage to the plant per lay was considerably more severe.

Root development and their relative activity throughout the various soil layers vere found to be dependent on the moisture regime of the root zone. It appears hat about 90% of water withdrawn from the root zone by evapotranspiration (ET) omes from the 0—120 cm layer. But roots were found even as deep as 200 cm. Root activity is confined mainly to the upper root zone if the soil is wetted to a hallow depth, or if, after being wetted to a great depth, the upper root zone is contantly kept moist by frequent rains or irrigations. On the other hand, a schedule f irrigation, which wets the root zone to its full depth at infrequent intervals, encourages the withdrawal of soil moisture from the deeper root zones, as soon as the noisture at the upper root zone is exhausted by ET.

Daily and seasonal ET was found to be dependent on the moisture regime of the oot zone as well as on the stage of plant development and climatic conditions such s temperature and humidity. For wheat growing in a relatively moist soil, daily T increased from about 2 mm in winter to about 5 mm in spring. However, if noisture in the root zone is reduced to the critical level, there is a reduction in T rate. At PWP transpiration practically ceases.

With the aid of soil and climatic data obtained from various places in the Negev, is possible to apply the results of the Gilat experiments to a wider area.

An economic analysis was carried out for the experimental years. The probability f success of irrigation schedule was examined in relation to the climatic conditions f each area. This problem is the subject of a separate lecture.

It seems that in the Gilat area in most years one irrigation given prior to wheat lanting can be recommended. In drier years, additional irrigations may be required.

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THE GEOLOGICAL SOCIETY OF ISRAEL

Session A (Tuesday morning)

Chairman W. BODENHEIMER

Genetic classification of clays and shales in Israel

Y. BENTOR, *Geological Survey, Ministry of Development, Jerusalem*

A systematic study of clay and shale occurrences in the country has only just begun, and no comprehensive picture can as yet be obtained. But some general observations can already be made.

Clays and shales play a rather subordinate role in the sedimentary column which is essentially carbonatic and sandy in its lower, and calcareous and dolomitic in its upper section. Nevertheless, a number of genetically different groups of shales and clays can be distinguished: the most widespread of these are *marine clays* which occur in varying amounts in practically all formations from Lower Cambrian onward, with the exception of Lower and Middle Eocene. Deposition of marine clays and shales reached its height of development at three distinct periods: Lower Cretaceous, Danian-Paleocene (Takiye and Hafir Formations), and Mio-Pliocene (Sakiye Formation). Secondary heights were reached in the Upper Jurassic and in the early Turonian of the Central Negev.

Accompanying minerals in these clays and shales point to a lagoonal and strongly reducing environment of deposition. Faunistic evidence, position in the sedimentary cycles, relations to breaks of sedimentation and to uncorformities seem to indicate that these deposits in general are shallow water and near-shore deposits. This may not apply in full to the Sakiye Formation. The few studies made so far on clays of this group have shown minerals of the montmorillonite group to be widespread, in good agreement with the probably alkaline nature of the environment.

The second group comprises clays and shales of *lacustral* origin, ranging from saline conditions (Sdom Series) to fresh water deposition (e.g. Pliocene). These clays occur as small intercalations within the Nubian sequence and reach their maximum development in the Nubian of the Jurassic (Estuarine) of the Ramon. They reappear during the Mio-Plio-Pleistocene lake cycles (Hatseva Series, Sdom Series, etc). Lacustral clays of the Nubian Series are predominantly kaolinitic, probably indicating an acid environment.

The Tertiary clays of this group have not been investigated so far.

The third group of clays and shales is *residual* in nature. They occur at three main horizons: the oldest of these occurs at the Precambrian—lowermost Cambrian

unconformity; it seems to be a good kaolin heavily charged with sand. This seems to indicate for the Eilat area a somewhat more humid climate than the present, but definitely not a tropical one. The second horizon occurs at the unconformity between Triassic and Jurassic. This is a true laterite, in places grading into bauxite. Kaolinite, boehmite and diaspore are major constituents of these clays, which correspondingly are distinguished by their high alumina content, frequently exceeding 60%. The third horizon of residual clays is found at the unconformity underlying the Middle Eocene transgression. This, too, represents a fossil soil, rich, however, in iron oxides and high in phosphate content, derived from the phosphatic sediments of Campanian and Maestrichtian time.

The two last horizons point to a tropical climate for the time of their formation.

The fourth group of clays is of *hydrothermal* origin and is connected with the Lower Cretaceous phase of magmatism. Dikes and sills of trachyte have been altered hydrothermally to kaolinite, frequently distinguished by high percentages of TiO_2. These hydrothermal clays are so far known in the Ramon area only.

Formation and weathering of clay minerals

DAN H. YAALON, *The Hebrew University of Jerusalem*

The processes by which primary minerals are broken down and altered chemically during weathering, and the mechanism whereby the clay minerals are formed, are outlined. The rate and course of the reaction are a product of the capacity factor and the environmental conditions under which the reactions take place. In certain cases the structural relationship among the main groups of the clay minerals enables transformations without requiring a complete decomposition of the clay lattice. Mixed structures are also commonly formed.

The integration of a multiplicity of separate weathering reactions into one framework has led to the construction of a weathering stability sequence of clay-size minerals[1]. Any assemblage of minerals in soils and sediments may be viewed as a halt stage in the more or less continuous weathering process.

The specific conditions leading to the formation and accumulation of particular clay minerals are discussed, with special reference to the occurrence of clay minerals in limestones and soils of Israel[2].

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Clay and quartz quarries in Israel

M. SKIDELSKY, *Beersheva*

Types of clays and quartz known and exploited, localities of quarries and known reserves are discussed. An analysis is made of the consumers of clay and quartz in Israel with respect to quantities available. Methods of mining, selection and transport and the possibilities for the future are evaluated.

Session B (Tuesday afternoon)

Chairman A. PARNESS

Clays, their chemical structure, properties and uses

WOLF BODENHEIMER, *Geological Survey, Ministry of Development, Jerusalem*

Research during recent years made it possible to establish the chemical structure of clays. Clays are now classified in a number of groups according to their structure, their properties are explained and their uses may be predicted.

The clay minerals, with one exception, are built up by layers of oxygen sheets which are held together mainly by silicon, aluminium or magnesium ions. Two sheets of oxygen layers may be arranged so that one oxygen atom of the upper sheet forms together with three oxygens of the lower sheet a tetrahedron in the centre of which stands one silicon or one aluminium. The second combination is of the kind in which three oxygens of the top layer form an octahedron with three oxygens of the bottom layer in the centre of the octaeder stands mostly an aluminium or a magnesium ion, which in many cases is replaced by other ions like Fe^{+++}, Zn^{++}, Cr^{+++}, etc. The order in which these tetrahedral or octahedral layers follow each other and the nature of the central ions are mainly responsible for the chemical properties and form the basis for the classification of clays.

The ability of the clays regarding swelling, absorption, ion exchange etc. determines their uses in various industries and the properties they impart to the soil mechanically and chemically.

Analysis of clay minerals by X-ray diffraction

L. HELLER

Some of the problems encountered in the analysis by X-ray diffraction methods are discussed. The characteristics of individual species, of the various types of mixtures which occur and of the different kinds of random layer stacking are described. A section is devoted to technique. Three groups of Israel clay minerals have been investigated: the kaolinitic clays of Wadi Ramon, two clays, S71 and S72, from the Eilat area, and the clays of the Greater Makhtesh.

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Wednesday afternoon

THE GENETICS CIRCLE

Wednesday afternoon

Chairman N. FEINBRUN

Chromosome numbers in the genus Colchicum

N. FEINBRUN, *Department of Botany, The Hebrew University of Jerusalem*

The results of the investigation of 9 species (7 from Israel, 1 from Sinai, 1 from Cyprus) are as follows:

(1) Low diploid numbers were found in *Colchicum* for the first time, allowing to establish with certainty $x = 7$ and $x = 9$.

(2) $x = 7$ is confined to Sect. *Bulbocodiae*; $x = 9$ was found in Sect. *Autumnales*, to which belong the majority of species studied caryologically so far. $2n = 36$ and $2n = 54$ can thus be regarded as tetra- and hexaploids. Hexaploids are much more common than tetraploids.

(3) Species with $2n = 38$ are relatively numerous. They can be interpreted either as tetraploid hexasomics ($4x + 2$) or as Gerstel's "alien addition types".

(4) Study of the synonymy of some species cited in the Chromosome Atlas shows that the $2n = 40$, 42 are intraspecific variants of species with $2n = 38$ and $2n = 44$.

(5) The interpretation of the chromosome numbers of *Colchicum* as an aneuploid series or as dibasic polyploidy are not supported by the present investigation.

Natural hybridization between Hordeum vulgare and H. spontaneum and the origin of H. agriocrithon

D. ZOHARY, *Department of Botany, The Hebrew University of Jerusalem*

Natural hybridization between six-rowed cultivated barley *Hordeum vulgare* and the wild two-rowed *H. spontaneum* seems to occur quite frequently in Israel. Hybrid swarms are especially common in neglected Arab fields, on the sides of roads and in other disturbed habitats.

Brittle six-rowed plants, identical with Åberg's *Hordeum agriocrithon*, are frequent in these hybrid swarms, occurring there among other intermediates and recombinants.

This fact raises serious doubt as to whether Åberg's *H. agriocrithon* is a true wild species. Its hybrid nature is further suggested by the nature of its dispersal unit. It is difficult to imagine *H. agriocrithon* as adjusted to dispersal and germination under wild conditions.

Hybridization between Aegilops species in Israel

H. ANKORI, *Department of Botany, The Hebrew University of Jerusalem*

Hybrid swarms between *Aegilops sharonensis* and *Ae. longissima* were found in several localities in the Sharon plain, in places where the natural habitat of these species had been badly disturbed by man. In the vicinity of these swarms, the parent species themselves exhibit a typical introgressive hybridization variation pattern.

The two *Aegilops* species differ from one another by a reciprocal translocation. The hybrid origin of the hybrid swarms was verified also by the presence of translocation heterozygotes.

Two species of subterranean clovers in Israel

D. ZOHARY AND J. KATZNELSON, *Department of Botany, The Hebrew University of Jerusalem*

Cytological and morphological study of subterranean clovers in Israel has shown that the previously reported $2n = 12$ Israeli "chromosomal race" or "cryptic species" is actually morphologically quite distinct from the ordinary $2n = 16$ *Trifolium subterraneum* L.

Both on morphological and genetic grounds the "Israeli race" with chromosome number $2n = 12$ should be regarded as a distinct new species.

Diploid and tetraploid populations of Dactylis glomerata in Israel and hybridization between them

U. NUR, *Department of Botany, The Hebrew University of Jerusalem*

Both diploid and tetraploid forms of *Dactylis glomerata* are found in Israel, and it is almost impossible to distinguish between them morphologically. The diploid form was found to occupy only small areas and is confined to the environments of Jerusalem, Nazareth and Safad. The tetraploid plants are widespread throughout the Mediterranean territory of Israel.

Contact areas between diploid and tetraploid populations were examined and found to contain natural triploids. Several facts indicate that in *Dactylis*, such triploids possibly serve as a bridge for gene-flow between the diploid and tetraploid levels.

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OF THE

GEOLOGICAL SOCIETY OF ISRAEL

HELD AT JERUSALEM, JULY 16, 1957

Session A (Tuesday morning)

Session B (Tuesday afternoon)

PROCEEDINGS OF THE MEETING

OF THE

GENETICS CIRCLE

HELD AT JERUSALEM, JULY 17, 1957

(Wednesday afternoon)

AUTHOR INDEX

SUBJECT INDEX

NOTICE TO CONTRIBUTORS

Contributors to the *Bulletin of the Research Council of Israel* should conform to the following recommendations of the editors of this journal in preparing manuscripts for the press.

Contributions must be original and should not have been published previously. When a paper has been accepted for publication, the author(s) may not publish it elsewhere unless permission is received from the Editor of this journal.

Papers may be submitted in English, French and Russian.

MANUSCRIPT

General

Papers should be written as concisely as possible. MSS should be typewritten on one side only and double-spaced, with side margins not less than 2.5 cm wide. Pages, including those containing illustrations, references or tables, should be numbered.

The Editor reserves the right to return a MS to the author for retyping or any alterations. Authors should retain copies of their MS.

Spelling

Spelling should be based on the Oxford Dictionary and should be consistent throughout the paper. Geographic and proper names in particular should be checked for approved forms of spelling or transliteration.

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Greek letters should be indicated in a legend preceding the MS, as well as by a pencil note in the margin on first appearance in the text.

When there is any room for confusion of symbols, they should be carefully differentiated, e.g. the letter "l" and the figure "1"; "O" and "0".

Abbreviations

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Every paper must be accompanied by a brief but comprehensive abstract. Although the length of the abstract is left to the discretion of the author, 3% of the total length of the paper is suggested.

References

In Sections A and C, and in Letters to the Editor in all Sections, references are to be cited in the text by number e.g., ... Taylor[3] ... and are to be arranged in the order o appearance.

In Sections B, D and E, the references are to be cited in the text by the author's name and date of publication in parenthesis, e.g., ... (Taylor 1932).... If the author's name is already mentioned in the text, then the year only appears in the parenthesis, e.g., ... found by Taylor (1932).... The references in these Sections are to be arranged in alphabetical order.

The following form should be used:

3. TAYLOR, G. I., 1932, *Proc. roy. Soc.*, A138, 41.

Book references should be prepared according to the following form.

4. JACKSON, F., 1930, *Thermodynamics*, 4th ed., Wiley, New York.

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Half tone photographs should be on glossy contrast paper.

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The place in which the figure is to appear should be indicated in the margin of the MS

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